bus

Agilent 75000 Series B

Agilent E1351A/52A/53A/57A/58A FET Multiplexers

Service Manual

Enclosed is the Service Manual for the Agilent E1351A/52A/53A/57A/58A FET Multiplexers. Insert this manual, along with any other VXIbus manuals that you have, into the binder that came with your Agilent Mainframe.

Agilent Technologies

Manual Part Number: E1351-90011
Printed in Malaysia E0912

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Agilent E1351A/52A/53A/57A/58A FET Multiplexer Module Service Manual
Edition 2 Rev 3

Printing History

The Printing History shown below lists all Editions and Updates of this manual and the printing date(s). The first printing of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct the current Edition of the manual. Updates are numbered sequentially starting with Update 1. When a new Edition is created, it contains all the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this printing history page. Many product updates or revisions do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

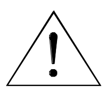
Edition 1 . . . . May 1993

Edition 2 (Part Number E1351-90011). . . . . June 1996

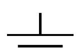
Edition 2 Rev 2 (Part Number E1351-90011) . . . . June 2006

Edition 2 Rev 3 (Part Number E1351-90011) . . . . September 2012

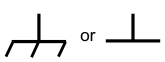
Safety Symbols



Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.



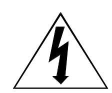
Indicates the field wiring terminal that must be connected to earth ground before operating the equipment—protects against electrical shock in case of fault.



Frame or chassis ground terminal—typically connects to the equipment's metal frame.

Alternating current (AC).

Direct current (DC).



Indicates hazardous voltages.

WARNING Calls attention to a procedure, practice, or condition that could cause bodily injury or death.

CAUTION Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

WARNINGS

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type.
DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

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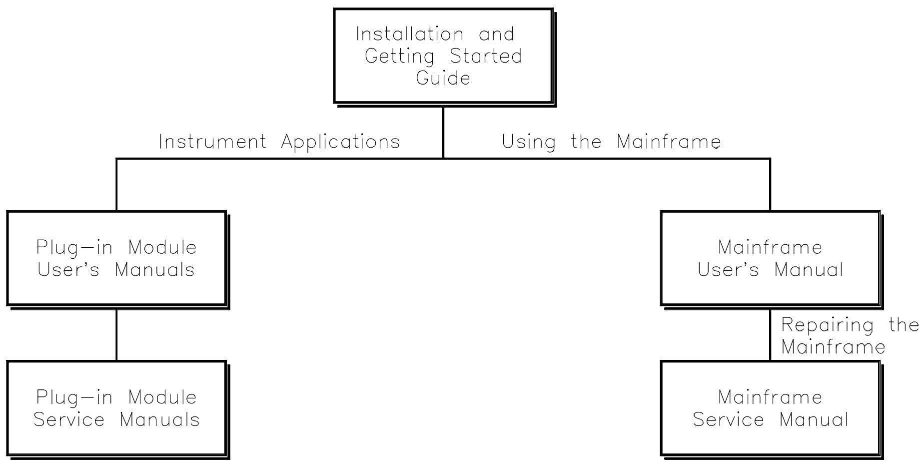
Declarations of Conformity for this product and for other Agilent products may be downloaded from the Internet. There are two methods to obtain the Declaration of Conformity:

- Go to **http://regulations.corporate.agilent.com/DoC/search.htm**. You can then search by product number to find the latest Declaration of Conformity.
- Alternately, you can go to the product web page **(e.g., www.agilent.com/find/E1351A),** click on the Document Library tab then scroll down until you find the Declaration of Conformity link.

Agilent 75000 Series B Service Documentation

Suggested Sequence to Use Manuals



Manual Descriptions

Installation and Getting Started Guide. This manual contains step-by-step instructions for all aspects of plug-in module and mainframe installation. Introductory programming information and examples are also included.

Mainframe User's Manual. This manual contains programming information for the mainframe, front panel operation information (for the Agilent E1301B mainframe), and general programming information for instruments installed in the mainframe.

Plug-In Module User's Manuals. These manuals contain plug-in module programming and configuration information. Each manual contains examples for the most-used module functions, and a complete SCPI command reference for the plug-in module.

Mainframe Service Manual. This manual contains service information for the mainframe. It contains information for ordering replaceable parts and exchanging assemblies. Information and procedures for performance verification, adjustment, preventive maintenance, troubleshooting, and repair are also included.

Plug-In Module Service Manuals. These manuals contain plug-in module service information. Each manual contains information for exchanging the module and/or ordering replaceable parts. Depending on the module, information and procedures for functional verification, operation verification, performance verification, adjustment, preventive maintenance, troubleshooting, and repair are also provided.

What's in this Manual

Manual Overview

This manual shows how to service the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers. Consult the appropriate *FET Multiplexer User's Manual* for additional information on installing, configuring, and operating each FET Multiplexer. Consult the appropriate mainframe user's manual for information on configuring and operating the mainframe.

Manual Content

Chapter	Title	Content
1	General Information	Provides a basic description and lists the test equipment required for service.
2	Verification Tests	Functional verification, operation verification, and performance verification tests.
3	Replaceable Parts	Lists replaceable parts for the module.
4	Service	Procedures to aid in fault isolation and repair of the module.

Table of Contents

Chapter 1 — General Information

Chapter 2 — Verification Tests

Chapter 3 — Replaceable parts

Chapter 4 — Service

Appendix A— Verification Tests - C Programs

Chapter 1
General Information

Introduction

This manual contains information required to test, troubleshoot, and repair the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers. See the appropriate *User's Manual* for additional information on the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A. Figure 1-1 shows the FET Multiplexers.

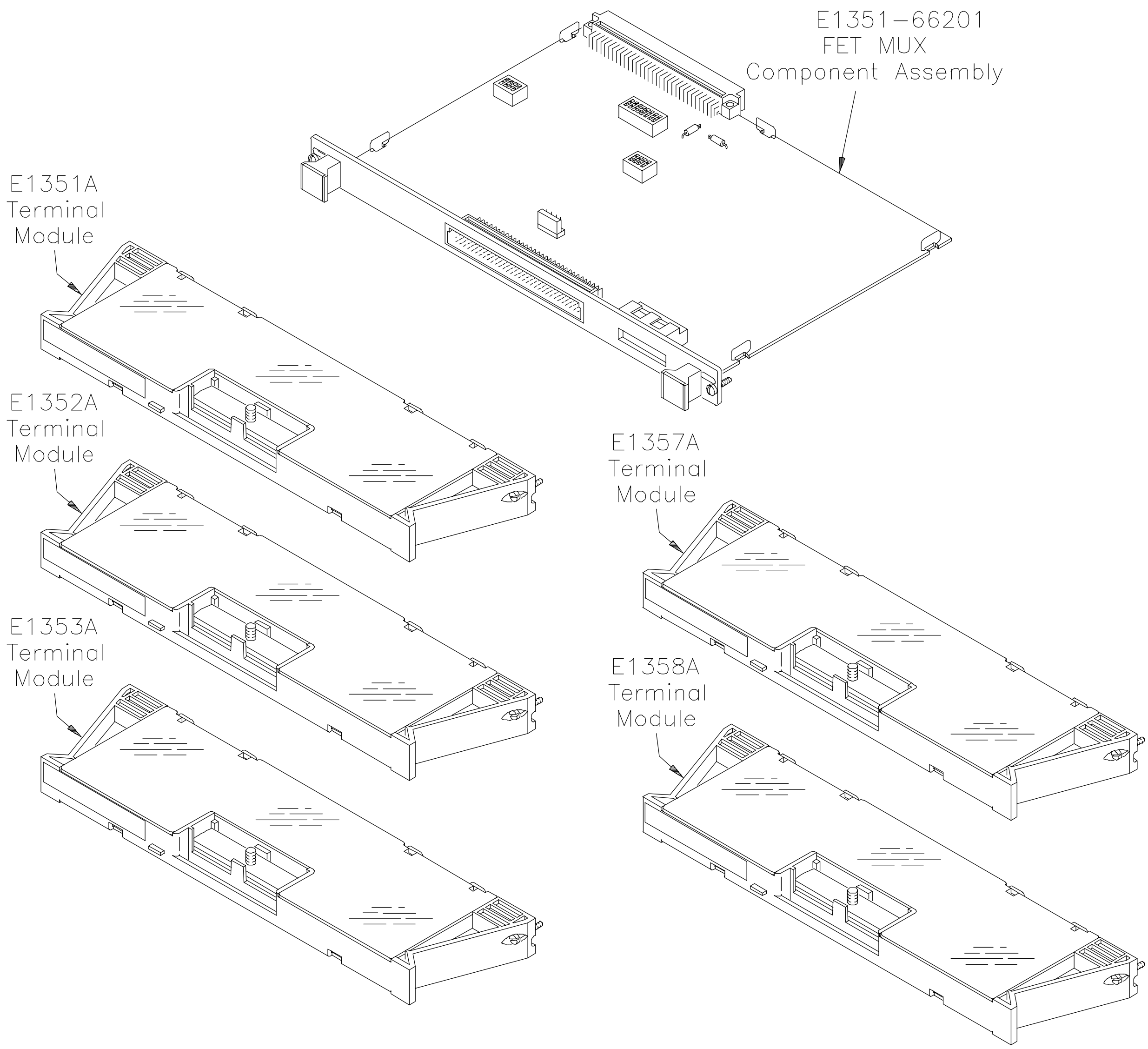


Figure 1-1. FET Multiplexers

Safety Considerations

This product is a Safety Class I instrument that is provided with a protective earth terminal when installed in the mainframe. Check the mainframe, FET Multiplexer, Terminal Block, and all related documentation for safety markings and instructions before operation or service.

Refer to the WARNINGS page (page ii) in this manual for a summary of safety information. Safety information for preventive maintenance, testing, and service follows and is also found throughout this manual.

Warnings

This section contains WARNINGS which must be followed for your protection when performing equipment maintenance or repair.

WARNING

SERVICE-TRAINED PERSONNEL ONLY. The information in this manual is for service-trained personnel who are familiar with electronic circuitry and are aware of the hazards involved. To avoid personal injury or damage to the instrument, do not perform procedures in this manual or do any servicing unless you are qualified to do so.

CHECK MAINFRAME POWER SETTINGS. Before applying power, verify that the mainframe setting matches the line voltage and that the correct fuse is installed. An uninterruptible safety earth ground must be provided from the main power source to the supplied power cord set.

GROUNDING REQUIREMENTS. Interruption of the protective (grounding) conductor (inside or outside the mainframe) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two-conductor outlet is not sufficient protection.)

IMPAIRED PROTECTION. Whenever it is likely that instrument protection has been impaired, the mainframe must be made inoperative and be secured against any unintended operation.

REMOVE POWER IF POSSIBLE. Some procedures in this manual may be performed with power supplied to the mainframe while protective covers are removed. Energy available at many points may, if contacted, result in personal injury. (If maintenance can be performed without power applied, the power should be removed.)

WARNING

USING AUTOTRANSFORMERS. If the mainframe is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the main's supply).

CAPACITOR VOLTAGES. Capacitors inside the mainframe may remain charged even when the mainframe has been disconnected from its source of supply.

USE PROPER FUSES. For continued protection against fire hazard, replace the line fuses only with fuses of the same current rating and type (such as normal blow, time delay, etc.). Do not use repaired fuses or short-circuited fuseholders.

Cautions

This section contains CAUTIONS which must be followed to avoid damage to the equipment when performing instrument maintenance or repair.

CAUTION

MAXIMUM VOLTAGE/CURRENT. The maximum voltage that may be applied between any connector pin and any other point, shield, or chassis is 15 VPeak.

STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the FET Multiplexer, observe anti-static techniques whenever working on a FET Multiplexer.

FET Multiplexer Description

The Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexer is an "instrument" in a VXIbus mainframe. As such, each FET Multiplexer is assigned an error queue, input and output buffers, and a status register.

NOTE

Instruments are based on the logical addresses of the plug-in modules. See the Agilent 75000 Series B Installation and Getting Started Guide to set the addresses to create an instrument.

The FET Multiplexer Module consists of a component assembly and a terminal block. There are five different terminal blocks, one for each application. The component assembly is the same for all applications. The applications supported by the component assembly are:

- Agilent E1351A 16-Channel FET Multiplexer
- Agilent E1352A 32-Channel Single Ended FET Multiplexer
- Agilent E1353A 16-Channel Thermocouple FET Multiplexer
- Agilent E1357A 8-Channel 120 Ω Strain Gage FET Multiplexer
- Agilent E1358A 8-Channel 350 Ω Strain Gage FET Multiplexer

Each terminal block configures the component assembly to the appropriate type of switch. The terminal card also contains the model identification code and installation of the terminal card before applying mainframe power ensures that the type of switch is properly identified. Optionally, the model identification can be set on the component assembly to allow it to be correctly identified without a terminal card installed.

Agilent E1351A Description

The **Agilent E1351A** provides high speed switching for up to 16 channels. The channels are numbered 00 to 15. Each channel provides connections for High (HI), Low (LO), and Guard (G), although only High and Low are switched. Guard for each channel is connected to chassis ground through a 10 k Ω resistor.

Agilent E1352A Description

The **Agilent E1352A** provides high-speed switching for up to 32 channels. The channels are numbered 00 to 31. A High (HI) connection is provided for each channel. Low (LO) and Guard (G) are common for all channels.

Agilent E1353A Description

The **Agilent E1353A** is identical to the Agilent E1351A, but contains a temperature reference thermistor on the terminal block to allow thermocouple temperature measurements when combined with either the Agilent E1326A or E1411B Multimeters.

Agilent E1357A Description

The **Agilent E1357A** provides up to eight channels of strain gage switching. Strain gage measurements are supported in 1/4 bridge, 1/2 bridge, and full bridge measurements with 120 Ω completion resistors. A strain gage excitation power supply is also provided.

Agilent E1358A Description

The **Agilent E1358A** is identical to the Agilent E1357A except the strain gage completion resistors are 350 Ω..

FET Multiplexer Specifications

See *Appendix A* of the appropriate *User's Manual* for Agilent E1351A, E1352A, E1353A, E1357A, and E1358A specifications. These specifications are the performance standards or limits against which the instrument may be tested.

FET Multiplexer Environment

The recommended operating environment for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexer is:

Environment	Temperature	Humidity
Operating	$0^{o}C$ to $+55^{o}C$	<65% relative ($0^{o}C$ to $+40^{o}C$)
Storage and Shipment	$-40^{o}C$ to $+75^{o}C$	<65% relative ($0^{o}C$ to $+40^{o}C$)

FET Multiplexer Serial Numbers

FET Multiplexers covered by this manual are identified by a serial number prefix listed on the title page. Agilent Technologies uses a two-part serial number in the form XXXXAYYYYY, where XXXX is the serial prefix, A is the country of origin (A=USA), and YYYYY is the serial suffix. The serial number prefix identifies a series of identical instruments. The serial number suffix is assigned sequentially to each instrument.

The serial number plate is located on the backplane connector. If the serial number prefix of your instrument is greater than the one listed on the title page, a Manual Update (as required) will explain how to adapt this manual to your instrument.

FET Multiplexer Options

There are no electrical or mechanical options available for the Agilent E1351A, E1352A, E1353A, E1357A, or E1358A FET Multiplexers.

Recommended Test Equipment

Table 1-1 lists the test equipment recommended for testing, adjusting, and servicing the FET Multiplexers. Essential requirements for each piece of test equipment are described in the Requirements column.

Table 1-1. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use*
Controller, GPIB	GPIB compatibility as defined by IEEE Standard 488-1987 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9000 Series 300 or IBM Compatible PC with BASIC	F,O, P,T
Mainframe	Compatible with FET Multiplexer	Agilent E1300B, E1301B, E1302A or E1401B, E1421A (requires E1405A/B)	F,O, P,T
Digital Multimeter	2-Wire Ohms (up to 10 kΩ) DC Volts (to 0.01 mV)	Agilent 3458A or Agilent 34401A	O,P,T
Power Supply	+10 Vdc ± 0.1 V	Agilent 6214C	P, T
Resistor	100 k Ω ± 1%	Agilent PN 0757-0465	P, T

* F = Functional Verification Tests, O = Operation Verification Tests, P = Performance Verification Tests, T = Troubleshooting

Inspection/ Shipping

This section contains initial (incoming) inspection and shipping guidelines for the FET Multiplexer.

Initial Inspection

Use the steps in Figure 1-2 as guidelines to perform initial inspection of a FET Multiplexer. Performance Verification tests are optional.

WARNING

To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to the shipping container or to the instrument.

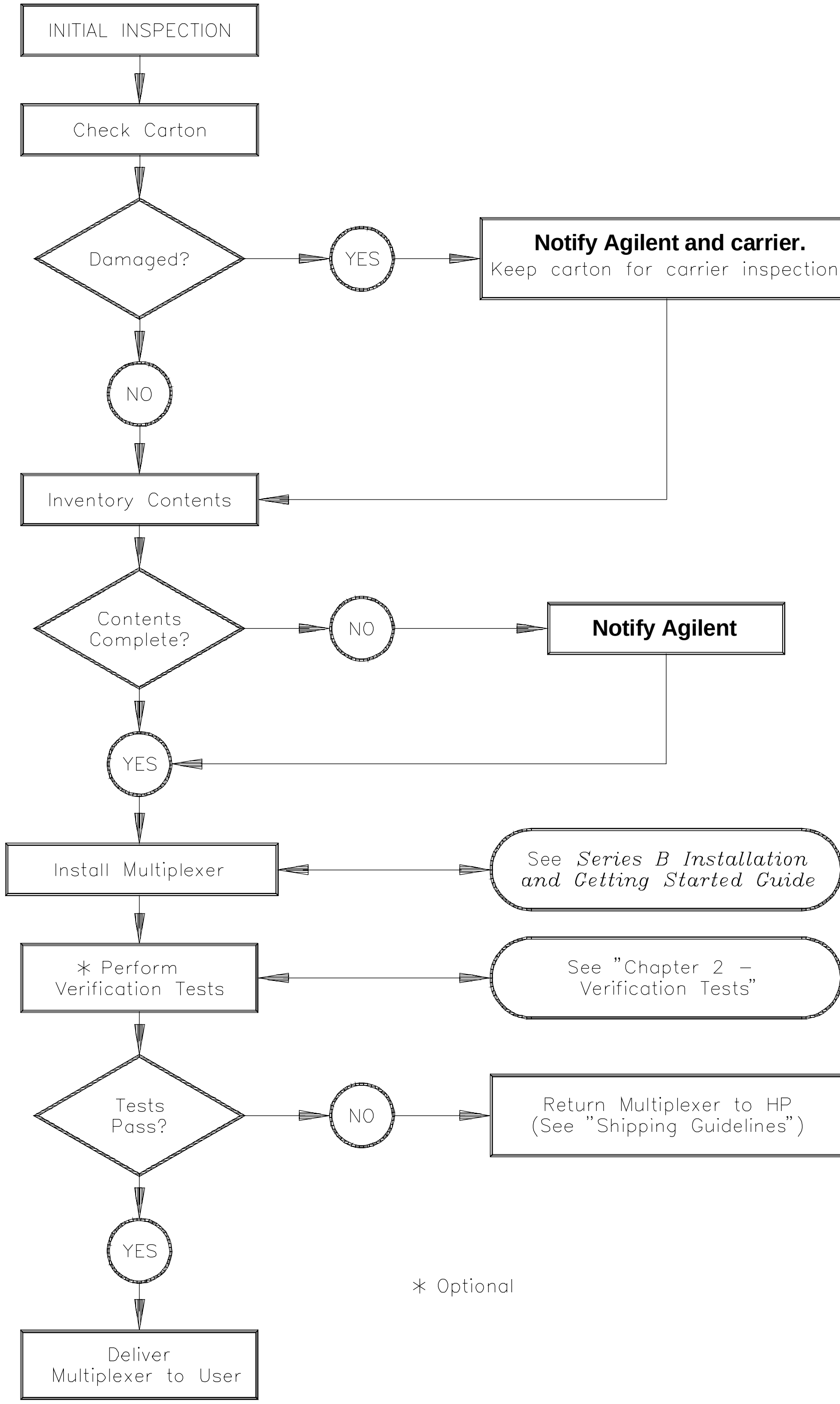
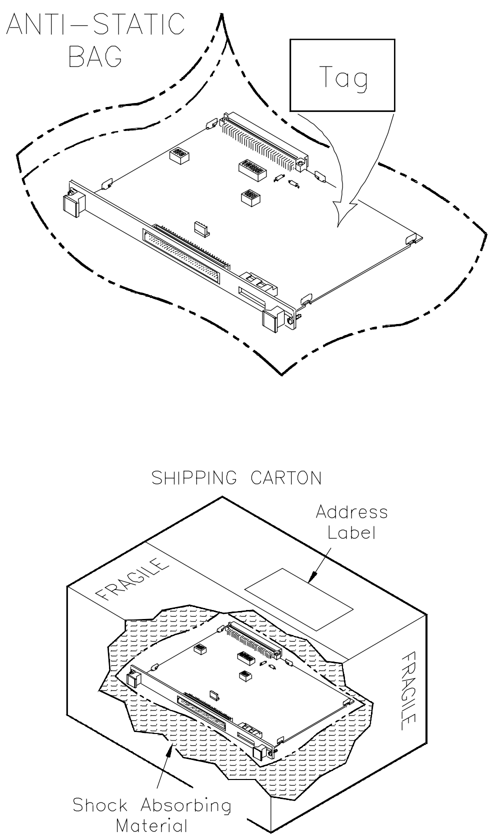


Figure 1-2. Initial (Incoming) Inspection Guidelines

Shipping Guidelines

Follow the steps in Figure 1-3 to return a FET Multiplexer to an Agilent Technologies Sales and Support Office or Service Center.



1 Prepare the FET Multiplexer

- Remove user wiring from the module
- Attach tag to module/pod that identifies
  - Owner
  - Model Number/Serial Number
  - Service Required
- Place tagged device in approved anti-static bag

2 Package the FET Multiplexer

- Place packaged FET Multiplexer in shipping carton*
- Place 75 to 100 mm (3 to 4 inches) of shock-absorbing material around the FET Multiplexer
- Seal the shipping carton securely
- Mark the shipping carton FRAGILE

3 Ship the FET Multiplexer to Agilent Technologies

- Place address label on shipping carton
- Send carton to Agilent Technologies

Figure 1-3. Packaging/Shipping Guidelines

* We recommend that you use the same shipping materials as those used in factory packaging (available from Agilent Technologies). For other (commercially-available) shipping materials, use a double wall-carton with minimum 2.4 MPa (350 psi) test.

Chapter 2
Verification Tests

Introduction

This chapter describes the verification tests for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A. The three levels of test procedures described in this chapter are used to verify that the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A:

- is functional (Functional Verification Test)
- meets selected testable specifications (Operation Verification)
- meets all testable specifications (Performance Verification)

Test Conditions/ Procedures

See Table 1-1 for test equipment requirements. You should complete the Performance Verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often. The verification tests assume that the person performing the tests understands how to operate the mainframe, the FET Multiplexer, and the specified test equipment. The test procedures do not specify equipment settings for test equipment except in general terms. It is assumed that a qualified, service-trained technician will select and connect the fixtures, adapters, and probes required for the test.

Performance Test Record

The results of each Performance Verification test may be recorded in Table 2-1, *Performance Test Record*, at the end of this chapter. You can make a copy of this form, if desired.

Verification Test Examples

Each verification test procedure includes an example program that performs the test. All example programs assume the following configuration:

- HP 9000 Series 200/300 computer
- BASIC programming language
- FET Multiplexer address 70914
- FET Multiplexer card number 1
- Agilent 3458A Digital Multimeter (DMM)

Functional Verification Test

The Functional Verification Test for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers consists of sending the *IDN? command and checking the response. This test can be used to verify that the FET Multiplexer is connected properly and is responding to a basic command.

Procedure

1. Verify that the FET Multiplexer is properly installed in the mainframe
2. Verify that the terminal block or test fixture is properly connected to the Multiplexer
3. Verify that the mainframe has passed its power-on test
4. Send *IDN? to the FET Multiplexer (see example following)
5. The return should be as follows (revision number may vary):

   HEWLETT-PACKARD,SWITCHBOX,0,A.07.00

NOTES

If the primary address setting, secondary address setting, or the interface select code is set incorrectly, the FET Multiplexer will not respond. Verify proper address selection before troubleshooting.

Example

An example follows which uses an HP 9000 Series 300 computer with BASIC and a FET Multiplexer address of 70914.

```
10  DIM A$[100]
20  OUTPUT 70914;"*IDN?"          !Send the ID command
30  ENTER 70914;A$                !Get response
40  PRINT A$
50  END
```

Operation Verification Test

The procedures in this section are used to provide a high level of confidence that the FET Multiplexer is meeting published specifications. The Operation Verification Test is a subset of the Performance Verification Tests and is suitable for checkout after performing repairs.

The Operation Verification Test is performed by completing the Closed Channel Resistance Test (Test 2-1) as described in the Performance Verification Test procedures. This test is usually sufficient to verify that the FET Multiplexer is meeting its specifications.

Performance Verification Tests

The procedure in this section is used to test the FET Multiplexer's electrical performance using the specifications in *Appendix A — Specifications* of the appropriate *FET Multiplexer User's Manual* as the performance standard.

There are two performance verification tests; *Test 2-1: Closed channel Resistance Test*, and *Test 2-2: Leakage Test*. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance.

Test Fixture

A Test Fixture is required to run the Performance Verification tests. Figure 2-1 shows the connections using an Agilent E1351A Terminal Block for the test fixture. The Agilent E1352A, E11353A, E1357A and E1358A Terminal Blocks are not recommended as test fixtures. You may want to order an extra terminal block to use as a test fixture, so you don't have to

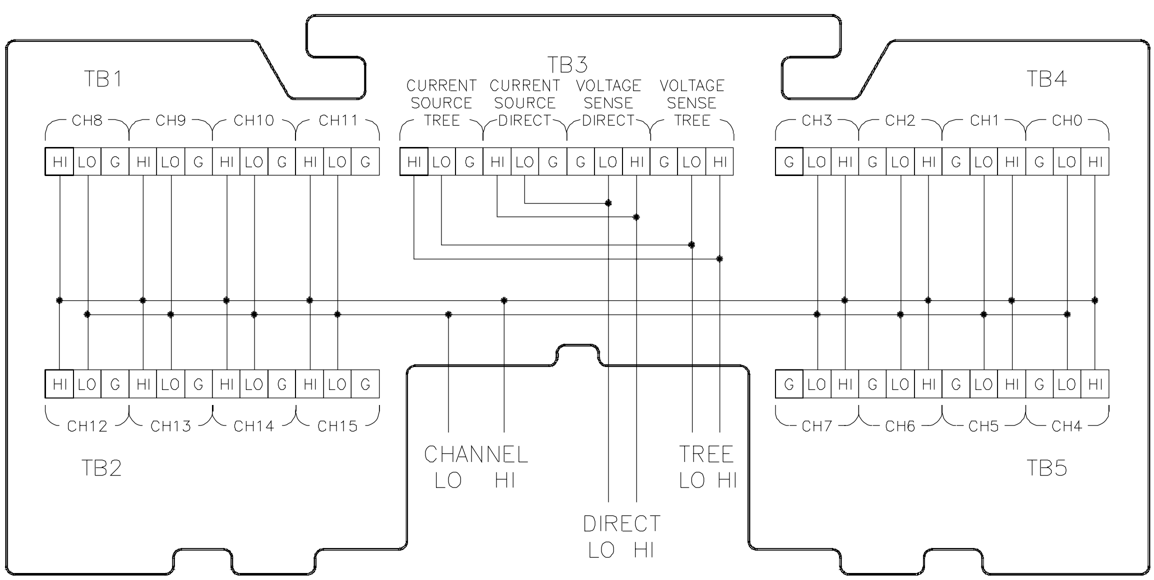


Figure 2-1. FET Multiplexer Test Fixture

re-wire each time the tests are performed. The Agilent E1351A terminal block and case assembly part number is E1351-80001.

Test 2-1: Closed Channel Resistance Test

This test first verifies that no FET switches are stuck in the on condition and then verifies that all channels meet the closed channel resistance specification for the FET Multiplexer. The channel HI, channel LO, A Tree, and B Tree switches are all independently tested.

HI Channel Measurements

1. **Make Hardware Connections**

   - Turn mainframe power OFF
   - Connect DMM as shown in Figure 2-2
   - Turn mainframe power ON

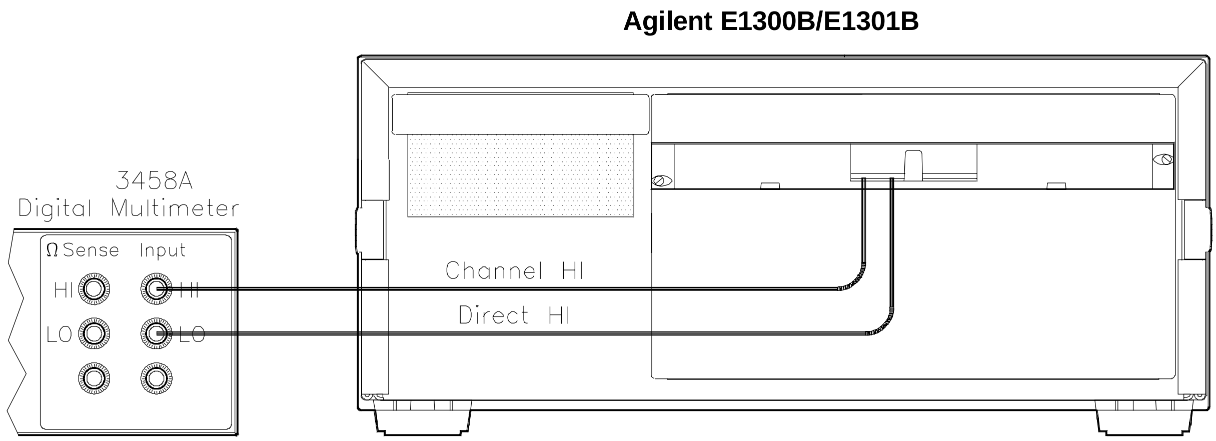


Figure 2-2. HI Channel Resistance Test Connections

2. **Check for Stuck Channels**

   - Send *RST to the FET Multiplexer to open all channels
   - Trigger the DMM with TRIG SGL and note reading
   - Verify the reading is greater than 10 kΩ

3. **Check HI Closed Channel Resistance**

   - Send CLOS (@*nn*00) to close channel 00, where *nn* is the card number (typically 01)
   - Trigger the DMM with TRIG SGL and note the reading
   - Enter the result in Table 2-1 for channel 00 HI
   - Send OPEN (@*nn*00) to open channel 00, where *nn* is the card number

4. **Repeat for Channels 01 through 15**

- Repeat step 3 for channels 01 through 15
- Use CLOS (@*nncc*), where *nn* is the card number and *cc* is the channel number

LO Channel Measurements

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM as shown in Figure 2-3
- Turn mainframe power ON

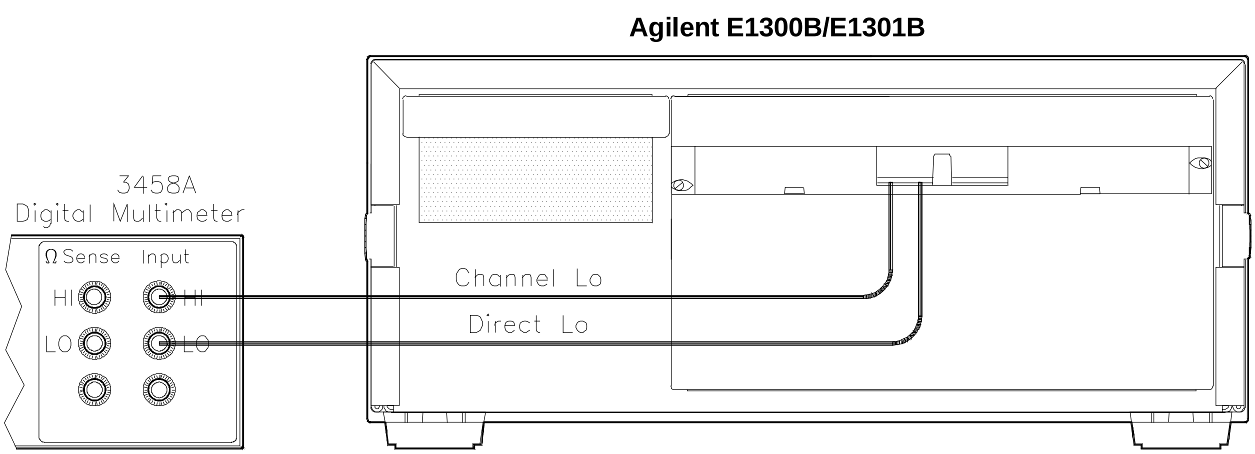


Figure 2-3. LO Channel Resistance Test Connections

2. **Check for Stuck Channels**

- Send *RST to the FET Multiplexer to open all channels
- Trigger the DMM with TRIG SGL and note reading
- Verify the reading is greater than 10 kΩ

3. **Check LO Closed Channel Resistance**

- Send CLOS (@*nn*00) to close channel 00, where *nn* is the card number (typically 01)
- Trigger the DMM with TRIG SGL and note the reading
- Enter the result in Table 2-1 for channel 00 LO
- Send OPEN (@*nn*00) to open channel 00, where *nn* is the card number

4. **Repeat for Channels 01 through 15**

- Repeat step 3 for channels 01 through 15
- Use CLOS (@*nncc*) and OPEN (@*nncc*), where *nn* is the card number and *cc* is the channel number

Tree Switch HI Channel Measurements

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM as shown in Figure 2-4
- Turn mainframe power ON

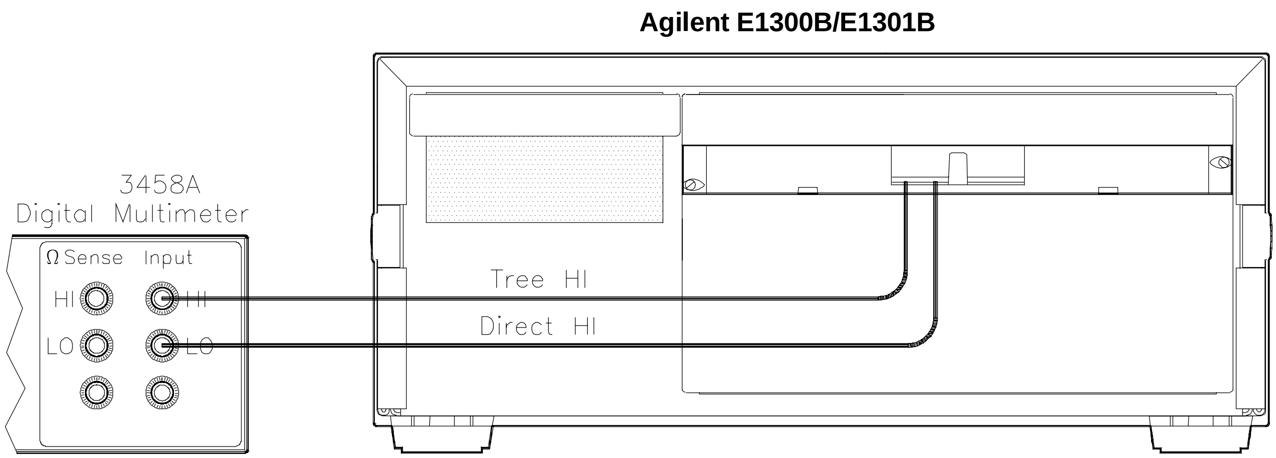


Figure 2-4. Tree HI Resistance Test Connections

2. **Check for Stuck Channels**

- Send *RST to the FET Multiplexer to open all channels
- Trigger the DMM with TRIG SGL and note reading
- Verify the reading is greater than 10 kΩ

3. **Check Tree Switch HI Closed Channel Resistance**

- Send SCAN:PORT ABUS to enable the tree switches
- Send CLOS (@*nn*00) to close channel 00 and the A tree switch, where *nn* is the card number (typically 01)
- Trigger the DMM with TRIG SGL and note the reading
- Enter the result in Table 2-1 for Tree A HI
- Send OPEN (@*nn*00) to open channel 00, where *nn* is the card number
- Send CLOS (@*nn*15) to close channel 15 and the B tree switch, where *nn* is the card number
- Trigger the DMM with TRIG SGL and note the reading
- Enter the result in Table 2-1 for Tree B HI
- Send *RST to the FET Multiplexer

Tree Switch LO Channel Measurements

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM as shown in Figure 2-5
- Turn mainframe power ON

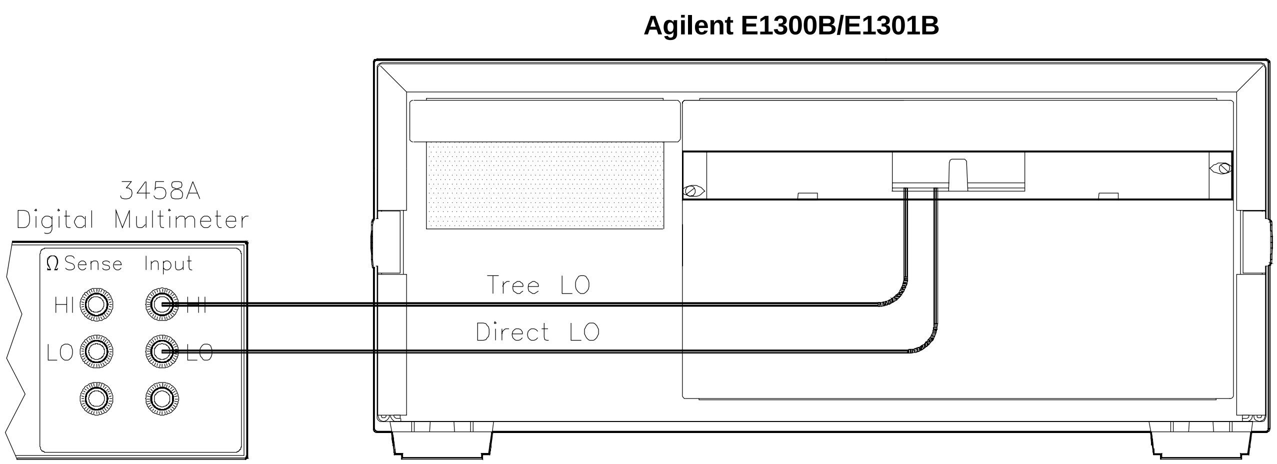


Figure 2-5. Tree LO Resistance Test Connections

2. **Check for Stuck Channels**

- Send *RST to the FET Multiplexer to open all channels
- Trigger the DMM with TRIG SGL and note reading
- Verify the reading is greater than 10 kΩ

3. **Check Tree Switch LO Closed Channel Resistance**

- Send SCAN:PORT ABUS to enable the tree switches
- Send CLOS (@*nn*00) to close channel 00 and the A tree switch, where *nn* is the card number (typically 01)
- Trigger the DMM with TRIG SGL and note the reading
- Enter the result in Table 2-1 for Tree A LO
- Send OPEN (@*nn*00) to open channel 00, where *nn* is the card number
- Send CLOS (@*nn*15) to close channel 15 and the B tree switch, where *nn* is the card number
- Trigger the DMM with TRIG SGL and note the reading
- Enter the result in Table 2-1 for Tree B LO
- Send *RST to the FET Multiplexer

Example: Closed Channel Resistance Test

This example performs a closed channel resistance test of all measurement paths. If a FET on resistance is >3.1 kΩ , the program prints a message indicating which channel has failed. Before the closed channel measurement, the program checks for stuck channels. If a stuck channel is found, the program prints a message and halts.

```
10!    RE-SAVE "CLOS_TEST"
20     ASSIGN @Dmm TO 722
30     ASSIGN @Mux TO 70914
40     DISP CHR$(129)
50     DIM Result(1,15),Tree(1,1),Path$(1)[4], Cc$[2],Ch$[2]
60     DATA HI,LO
70     READ Path$(*)
80     Cc$ = "01"               ! Card number
90     !
100    ! Start test
110    !
120    CLEAR SCREEN
130    PRINT "Install Component Assembly and Test Fixture"
140    PRINT
150    PRINT "  1.   Turn mainframe and Agilent 3458A DMM power OFF"
160    PRINT "  2.   Connect GPIB cable between mainframe and DMM"
170    PRINT "  3.   Install component assembly into mainframe"
180    PRINT "  4.   Attach test fixture to component assembly"
190    PRINT "  5.   Turn mainframe and DMM power ON"
200    PRINT "  6.   Press Continue when ready to begin testing"
210    PAUSE
220    !
230    !  Measure closed channel resistance
240    !
250    FOR I = 0 TO 1
260      CLEAR SCREEN
270      PRINT TABXY(1,1), "Channel  ";Path$(I);"  to Direct   ";Path$(I);" Measurements"
280      PRINT TABXY(1,3),"Connect DMM Input HI lead to Channel ";Path$(I)
290      PRINT TABXY(1,4),"Connect DMM Input LO lead to Direct  ";Path$(I)
300      DISP "Press Continue when connections are complete"
310      PAUSE
320      OUTPUT @Dmm;"PRESET NORM;FUNC OHM"
330      OUTPUT @Mux;"*RST"
340      !
350      ! Check for stuck channels
360      !
```

```
370       OUTPUT @Dmm;"TRIG SGL"
380       ENTER @Dmm;Value
390       IF Value<10000 THEN
400           CLEAR SCREEN
410           PRINT "Measurement indicates a stuck channel"
420           PRINT "Correct the problem before proceeding"
430           STOP
440       END IF
450       CLEAR SCREEN
460       FOR J = 0 TO 15
470           IF J<10 THEN
480               Ch$="0"&VAL$(J)
490           ELSE
500               Ch$=VAL$(J)
510           END IF
520           OUTPUT @Mux;"CLOS (@"&Cc$&Ch$&")"
530           OUTPUT @Dmm;"TRIG SGL"
540           ENTER @Dmm;Result(I,J)
550           OUTPUT @Mux;"OPEN (@"&Cc$&Ch$&")"
560           IF Result(I,J)>3100 THEN
570               PRINT "Resistance for channel  ";J;"  ";
Path$(I);"  is > 3.1 kOhms"
580           END IF
590       NEXT J
600       PRINT "Measurements complete for channel  ";Path$(I)
610       IF I=0 THEN
620           DISP "Press Continue for channel  ";Path$(I+1);"  measurements"
630           PAUSE
640       END IF
650     NEXT I
660     PRINT "Measurements complete for channel HI and LO"
670     DISP "Press Continue for Tree Switch measurements"
680     PAUSE
690     !
700     ! Tree Switch measurements
710     !
720     FOR I = 0 TO 1
730       CLEAR SCREEN
740       PRINT TABXY(1,1), "Tree  ";Path$(I);"  to Direct   ";Path$(I);
"  measurements"
750       PRINT TABXY(1,3),"Connect DMM Input HI lead to Tree  ";Path$(I)
760       PRINT TABXY(1,4),"Connect DMM Input LO lead to Direct  ";Path$(I)
770       DISP "Press Continue when connections are complete"
```

```
780     PAUSE
790     OUTPUT @Dmm;"PRESET NORM;FUNC OHM"
800     OUTPUT @Mux;"*RST"
810     !
820     ! Check for stuck tree switches
830     !
840     OUTPUT @Dmm;"TRIG SGL"
850     ENTER @Dmm;Value
860     IF Value<10000 THEN
870         CLEAR SCREEN
880         PRINT "Measurement indicates a stuck tree switch"
890         PRINT "Correct the problem before proceeding"
900         STOP
910     END IF
920     CLEAR SCREEN
930     FOR J = 0 TO 1
940         IF J=0 THEN
950             Ch$="00"
960         ELSE
970             Ch$="15"
980         END IF
990         OUTPUT @Mux;"SCAN:PORT ABUS"
1000    OUTPUT @Mux;"CLOS (@"&Cc$&Ch$&")"
1010    OUTPUT @Dmm;"TRIG SGL"
1020    ENTER @Dmm;Tree(I,J)
1030    OUTPUT @Mux;"OPEN (@"&Cc$&Ch$&")"
1040    IF Tree(I,J)>3100 THEN
1050        IF Ch$="00" THEN
1060            PRINT "Resistance for A Tree  Switch  ";Path$(I);
"  is > 3.1 kOhms"
1070        ELSE
1080            PRINT "Resistance for B Tree  Switch  ";Path$(I);
"  is > 3.1 kOhms"
1090        END IF
1100    END IF
1110   NEXT J
1120   PRINT "Measurements complete for tree switch  ";Path$(I)
1130   IF I=0 THEN
1140    DISP "Press Continue for Tree Switch  ";Path$(I+1);
"  measurements"
1150    PAUSE
1160   END IF
1170  NEXT I
```

```
1180  PRINT "Closed channel resistance measurements complete"
1190  DISP "Press Continue to print measurement results"
1200  PAUSE
1210  CLEAR SCREEN
1220  !
1230  ! Print results
1240  !
1250  Format1:IMAGE "Channel ",DD,"      HI ",DDDDD," Ohms        LO ",DDDDD," Ohms"
1260  Format2:IMAGE "Tree     ",K,"        HI ",DDDDD," Ohms        LO ",DDDDD," Ohms"
1270  PRINT "Closed channel resistance measurement results"
1280  FOR J=0 TO 15
1290    PRINT USING Format1;J,Result(0,J),Result(1,J)
1300  NEXT J
1310  PRINT
1320  PRINT USING Format2;"A",Tree(0,0),Tree(0,1)
1330  PRINT USING Format2;"B",Tree(1,0),Tree(1,1)
1340  END
```

Typical Result

Closed channel resistance measurement results

Channel	0	HI	989 Ohms	LO	1004 Ohms
Channel	1	HI	991 Ohms	LO	979 Ohms
Channel	2	HI	1001 Ohms	LO	989 Ohms
Channel	3	HI	990 Ohms	LO	1000 Ohms
Channel	4	HI	988 Ohms	LO	999 Ohms
Channel	5	HI	1002 Ohms	LO	995 Ohms
Channel	6	HI	1010 Ohms	LO	1000 Ohms
Channel	7	HI	998 Ohms	LO	998 Ohms
Channel	8	HI	1006 Ohms	LO	1008 Ohms
Channel	9	HI	1000 Ohms	LO	1002 Ohms
Channel	10	HI	995 Ohms	LO	988 Ohms
Channel	11	HI	999 Ohms	LO	990 Ohms
Channel	12	HI	1000 Ohms	LO	1000 Ohms
Channel	13	HI	989 Ohms	LO	991 Ohms
Channel	14	HI	979 Ohms	LO	989 Ohms
Channel	15	HI	1004 Ohms	LO	995 Ohms
Tree	A	HI	988 Ohms	LO	991 Ohms
Tree	B	HI	992 Ohms	LO	998 Ohms

Test 2-2: Leakage Test

The test verifies the input impedance by measuring the voltage drop across a known resistor in series with the input impedance. Leakage is measured from HI to LO, HI to Chassis, and LO to Chassis. Because of the solid state nature of the switches and input protection, the leakage is measured at both +10 Vdc and -10 Vdc.

HI to LO Leakage

1. **Make Hardware Connections**

- Turn power supply, DMM, and mainframe power OFF
- Connect DMM, power supply, and resistor as shown in Figure 2-6
- Turn power supply, DMM, and mainframe power ON
- Set power supply output to +10 Vdc ± 0.1 Vdc

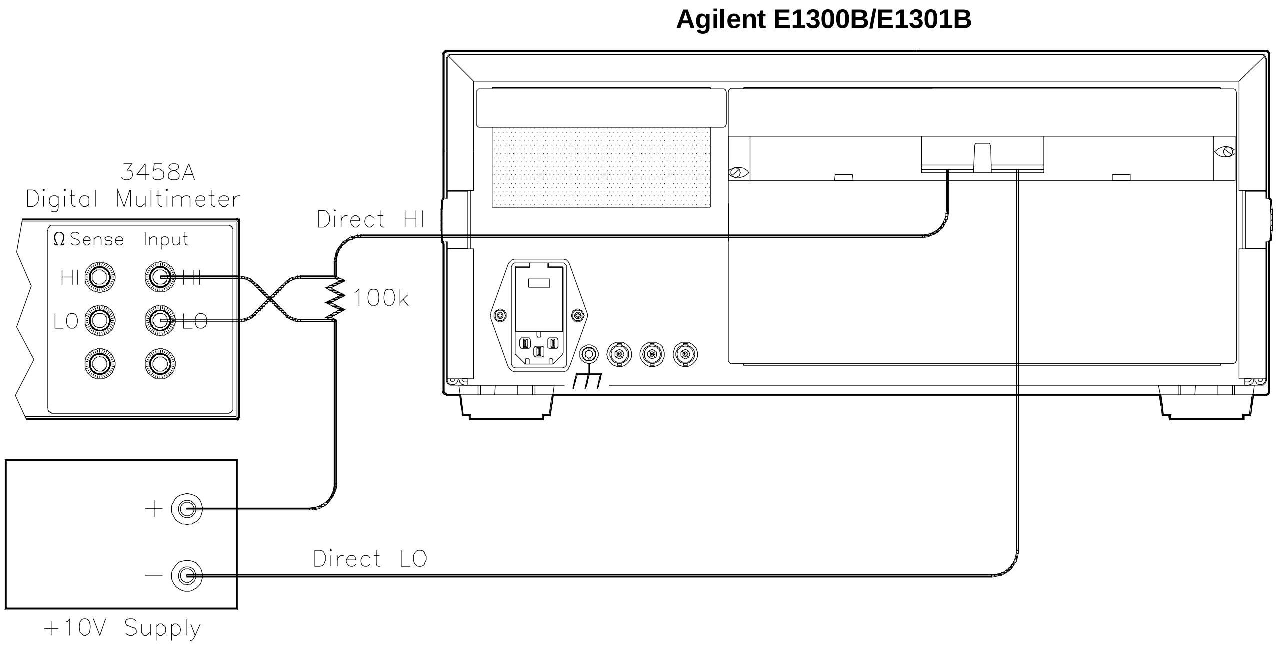


Figure 2-6. Positive HI to LO Leakage Connections

2. **Check Direct Terminals Leakage**

- Send *RST to FET Multiplexer
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, HI to LO, Direct
- The DMM measurement should be less than 0.010 Vdc. A measurement out of this range indicates a failure of the FET Multiplexer and troubleshooting/repair/replacement procedures, described in Chapter 4, should be performed before proceeding with Test 2-2

3. **Check Channels Leakage**

   - Send CLOS(@*nn*00) to the FET Multiplexer to close channel 00, where *nn* is card number (typically 01)
   - Send TRIG SGL to DMM
   - Record the DMM reading in Table 2-1
     Positive Polarity, HI to LO, Channels
   - Send OPEN (@*nn*00) to the FET Multiplexer

4. **Check Tree Leakage**

   - Send SCAN:PORT ABUS to the FET Multiplexer to enable the Tree Switches
   - Send CLOS(@*nn*00) to the FET Multiplexer to close channel 00 and Tree Switch A, where *nn* is the card number (typically 01)
   - Send TRIG SGL to DMM
   - Record the DMM reading in Table 2-1
     Positive Polarity, HI to LO, Tree A
   - Send OPEN (@*nn*00) to the FET Multiplexer
   - Send CLOS(@*nn*15) to the FET Multiplexer to close channel 15 and Tree Switch B
   - Send TRIG SGL to DMM
   - Record the DMM reading in Table 2-1
     Positive Polarity, HI to LO, Tree B
   - Send *RST to the FET Multiplexer

5. **Change Polarity**

   - Turn power supply and mainframe power OFF
   - Connect DMM, power supply, and resistor as shown in Figure 2-7
   - Turn power supply and mainframe power ON
   - Set power supply output to +10 Vdc ± 0.1 Vdc

6. **Repeat Steps 2 through 4**

   - Record all results in Table 2-1 as
     Negative Polarity, HI to LO

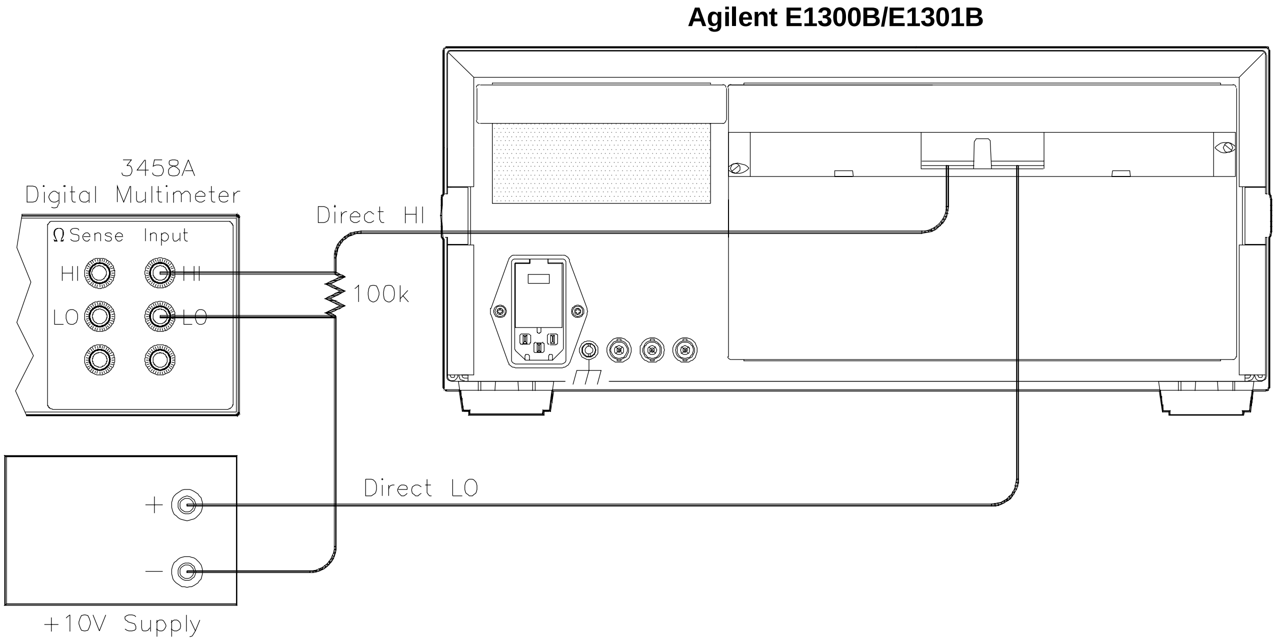


Figure 2-7. Negative HI to LO Leakage Connections

HI to Chassis Leakage

1. **Make Hardware Connections**

   - Turn power supply and mainframe power OFF
   - Connect DMM, power supply, and resistor as shown in Figure 2-8
   - Turn power supply and mainframe power ON

2. **Check Direct Terminals Leakage**

   - Send *RST to FET Multiplexer
   - Send TRIG SGL to DMM
   - Record the DMM reading in Table 2-1
     Positive Polarity, HI to Chassis, Direct
   - The DMM measurement should be less than 0.010 Vdc.
     A measurement out of this range indicates a failure of the FET Multiplexer

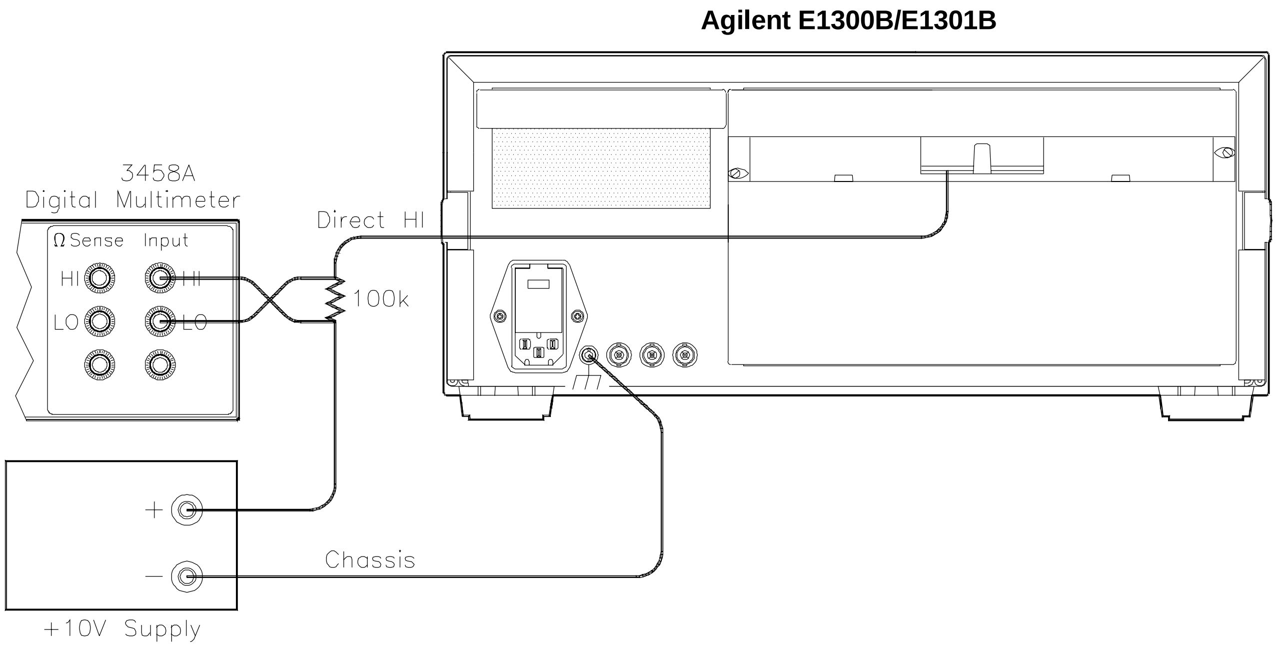


Figure 2-8. Positive HI to Chassis Leakage Connections

3. **Check Channels Leakage**

- Send CLOS(@*nn*00) to the FET Multiplexer, where *nn* is the channel number (typically 01)
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, HI to Chassis, Channels
- Send OPEN (@*nn*00) to the FET Multiplexer

4. **Check Tree Leakage Current**

- Send SCAN:PORT ABUS to the FET Multiplexer
- Send CLOS(@*nn*00) to the FET Multiplexer to close channel 00 and Tree A, where *nn* is the card number (typically 01)
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, HI to Chassis, Tree A
- Send OPEN (@*nn*00) to the FET Multiplexer

- Send CLOS(@*nn*15) to the FET Multiplexer to close channel 15 and tree B
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, HI to Chassis, Tree B
- Send *RST to the FET Multiplexer

5. **Change Polarity**

- Turn power supply and mainframe power OFF
- Connect DMM, power supply, and resistor as shown in Figure 2-9
- Turn power supply and mainframe power ON
- Set power supply output to +10 Vdc ± 0.1 Vdc

6. **Repeat Steps 2 through 4**

- Record all results in Table 2-1 as
  Negative Polarity, HI to Chassis

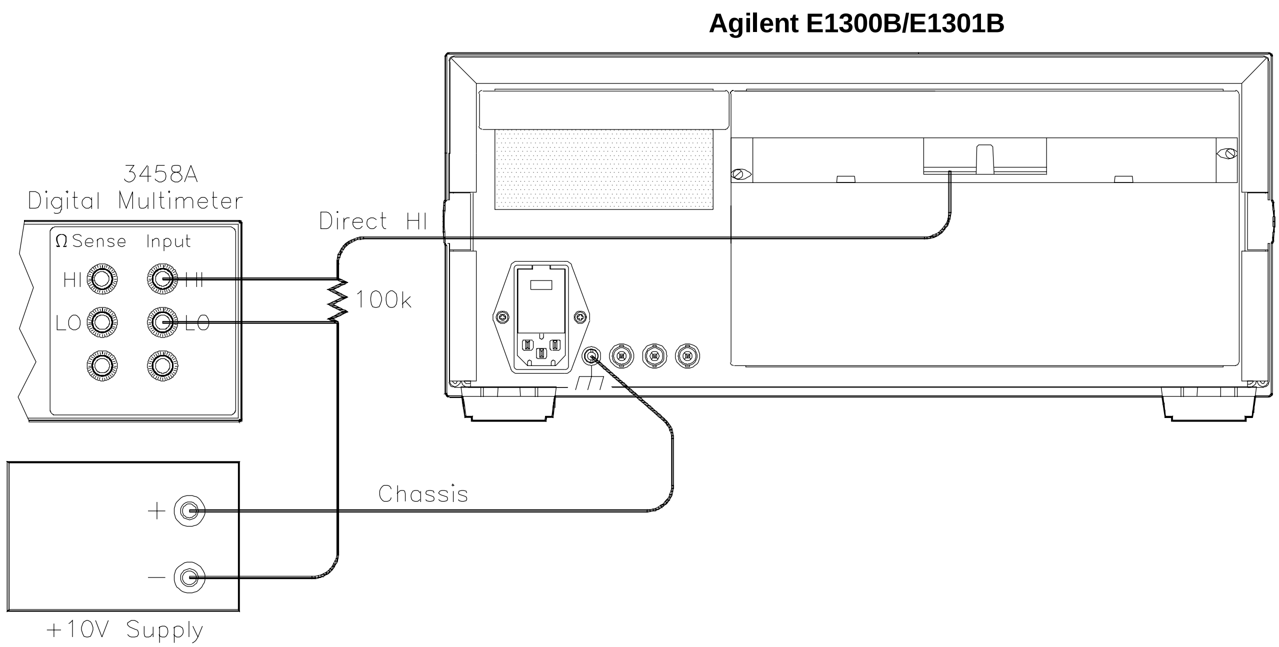


Figure 2-9. Negative HI to Chassis Leakage Connections

LO to Chassis Leakage

1. **Make Hardware Connections**

- Turn power supply and mainframe power OFF
- Connect DMM, power supply, and resistor as shown in Figure 2-10
- Turn power supply and mainframe power ON

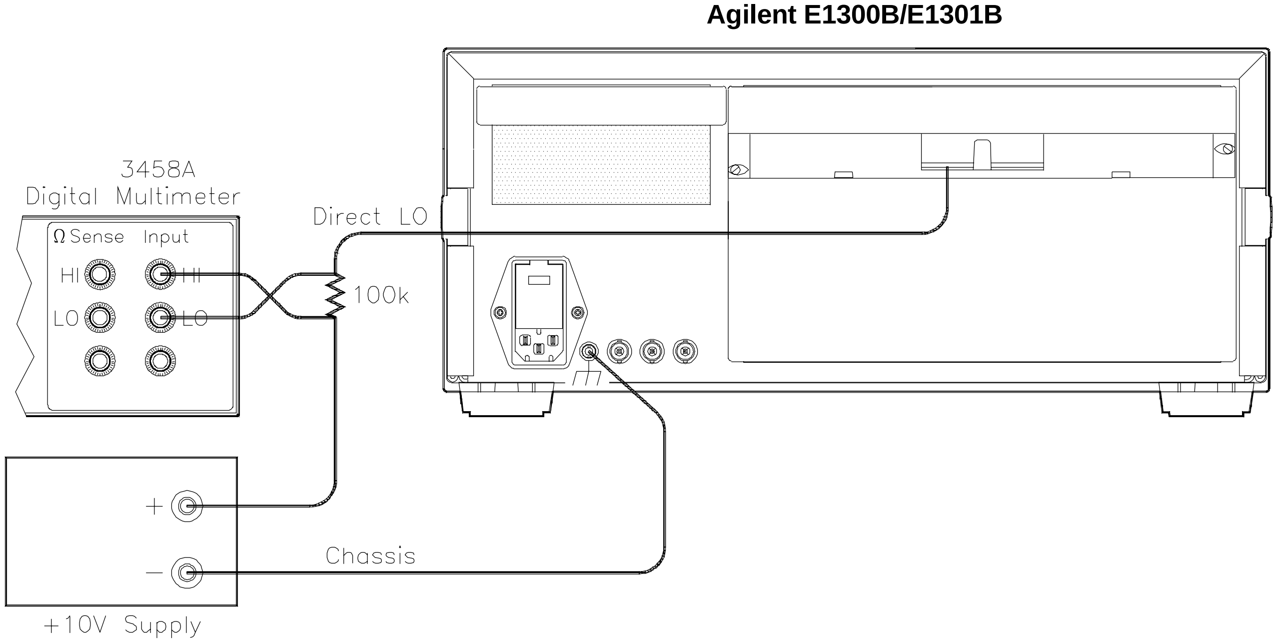


Figure 2-10. Positive LO to Chassis Leakage Connections

2. **Check Direct Terminals Leakage Current**

- Send *RST to FET Multiplexer
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, LO to Chassis, Direct
- The DMM measurement should be less than 0.010 Vdc.
  A measurement out of this range indicates a failure of the FET Multiplexer.

3. **Check Channels Leakage**

- Send CLOS(@*nn*00) to the FET Multiplexer, where *nn* is the card number (typically 01)
- Send TRIG SGL to DMM

- Record the DMM reading in Table 2-1
  Positive Polarity, LO to Chassis, Channels
- Send OPEN (@*nn*00) to the FET Multiplexer

4. **Check Tree Leakage Current**

- Send SCAN:PORT ABUS to the FET Multiplexer
- Send CLOS(@*nn*00) to the FET Multiplexer to close channel 00 and Tree A, where *nn* is the card number (typically 01)
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, LO to Chassis, Tree A
- Send OPEN (@*nn*00) to the FET Multiplexer
- Send CLOS(@*nn*15) to the FET Multiplexer to close channel 15 and Tree B
- Send TRIG SGL to DMM
- Record the DMM reading in Table 2-1
  Positive Polarity, LO to Chassis, Tree B
- Send *RST to the FET Multiplexer

5. **Change Polarity**

- Turn power supply and mainframe power OFF
- Connect DMM, power supply, and resistor as shown in Figure 2-11
- Turn power supply and mainframe power ON

6. **Repeat Steps 2 through 4**

- Record all results in Table 2-1 as
  Negative Polarity, LO to Chassis

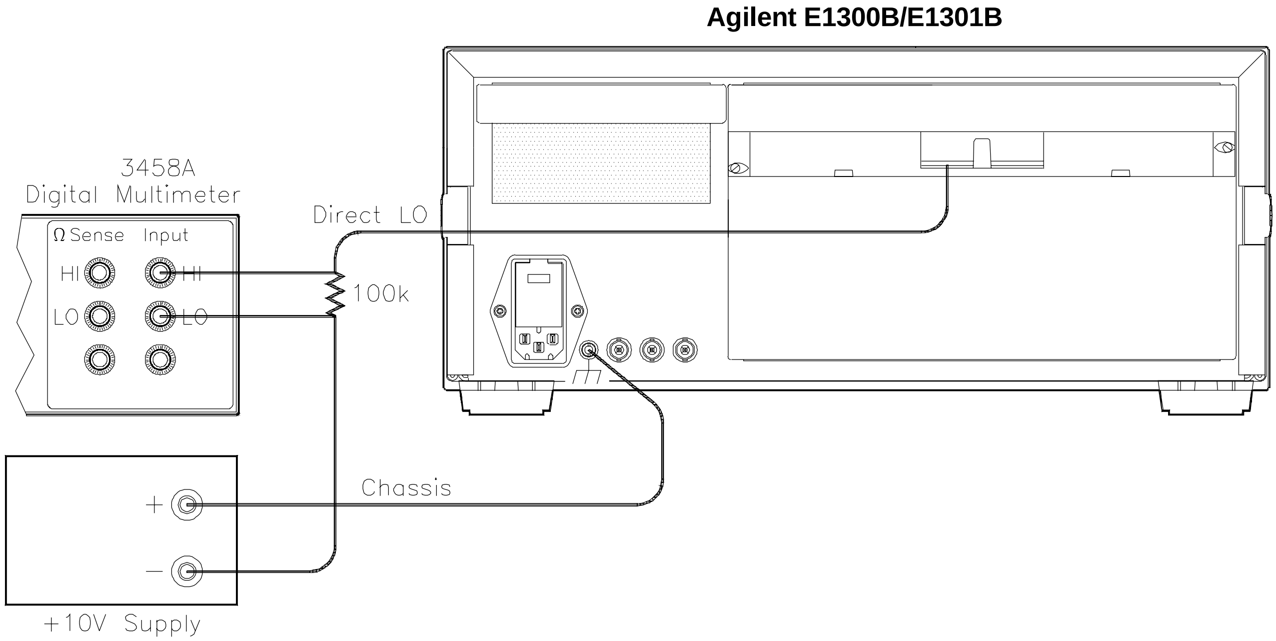


Figure 2-11. Negative LO to Chassis Leakage Connections

Example: Leakage Current Test

This example performs a leakage test from HI to LO, HI to Chassis, and LO to Chassis. If the leakage is too high (caused by a failure of the input impedance), the test prints a message indicating which leakage path has failed and halts.

```
10!  RE-SAVE "LEAK_TEST"
20   ASSIGN @Dmm TO 722
30   ASSIGN @Mux TO 70914
40   DISP CHR$(129)
50   DIM Result(5,3), Path$(5,3)[16],Cc$[2]
60   DATA Power Supply HI,Direct HI,LO,Direct LO
70   DATA Direct HI,Power Supply LO,HI,Direct LO
80   DATA Power Supply HI,Direct LO,LO,Chassis
90   DATA Direct HI,Power Supply LO,HI,Chassis
100  DATA Power Supply HI,Direct LO,LO,Chassis
110  DATA Direct LO,Power Supply LO,HI,Chassis
120  READ Path$(*)
130  Cc$="01"     ! Card Number
140  CLEAR SCREEN
150  PRINT "Install component assembly and test fixture"
160  PRINT
```

```
170  PRINT  " 1.    Turn mainframe, power supply, and DMM power OFF"
180  PRINT  " 2.    Connect GPIB cable between mainframe and DMM"
190  PRINT  " 3.    Install component assembly into mainframe"
200  PRINT  " 4.    Attach test fixture to component assembly"
210  PRINT  " 5.    Turn mainframe and DMM power ON"
220  PRINT  " 6.    Press Continue when ready to begin testing"
230  PAUSE
240  !
250  ! Start Test
260  !
270  OUTPUT @Mux;"*RST"
280  OUTPUT @Dmm;"PRESET NORM;FUNC DCV"
290  FOR I=0 TO 5
300      CLEAR SCREEN
310      PRINT  " 1.  Connect 100 kOhm resistor from DMM Input HI to DMM Input LO"
320      PRINT  " 2.  Connect DMM Input HI lead to  ";Path$(I,0)
330      PRINT  " 3.  Connect DMM Input LO lead to ";Path$(I,1)
340      PRINT  " 4.  Connect Power Supply ";Path$(I,2);" to ";Path$(I,3)
350      PRINT  " 5.  Turn ON  power supply and set output for +10 Vdc"
360      DISP "Press Continue when connections are complete"
370      PAUSE
380      OUTPUT @Dmm;"TRIG SGL"
390      ENTER @Dmm;Result (I,0)
400      IF Result (I,0) > .01 THEN
410          PRINT "Direct path leakage out of tolerance";Result (I,0);" Volts"
420      END IF
430      ! Channel check
440      OUTPUT @Mux;"CLOS (@"&Cc$&"00)"
450      OUTPUT @Dmm;"TRIG SGL"
460      ENTER @Dmm;Result (I,1)
470      IF Result (I,1) > .01 THEN
480          PRINT "Channel path leakage out of tolerance";Result (I,1);" Volts"
490      END IF
500      OUTPUT @Mux;"*RST"
510      ! Tree check
520      OUTPUT @Mux;"SCAN:PORT ABUS"
530      OUTPUT @Mux;"CLOS (@"&Cc$&"00)"
540      OUTPUT @Dmm;"TRIG SGL"
550      ENTER @Dmm;Result (I,2)
560      IF Result(I,2) > .01 THEN
570          PRINT "Tree A path leakage out of tolerance";Result (I,2);" Volts"
```

```
580       END IF
590       OUTPUT @Mux;"OPEN (@"&Cc$&"00)"
600       OUTPUT @Mux;"CLOS (@"&Cc$&"15)"
610       OUTPUT @Dmm;"TRIG SGL"
620       ENTER @Dmm;Result (I,3)
630       IF Result (I,3) > .01 THEN
640            PRINT "Tree B path leakage out of tolerance ";Result$(I,3);" Volts"
650       END IF
660       OUTPUT @Mux;"*RST"
670       IF I < 5 THEN
680            PRINT "Test ";I+1;" complete"
690            PRINT "Turn power supply OFF"
700            PRINT "Press Continue for  test ";I+2
710            PAUSE
720       END IF
730   NEXT I
740   PRINT "Leakage tests complete"
750   DISP "Press Continue to print measurement results"
760   PAUSE
770   CLEAR SCREEN
780   !
790   ! Print results
800   !
810   Format:IMAGE K,3X,D.DDDD," Vdc",3X,D.DDDD," Vdc",3X,D.DDDD,
" Vdc",3X,D.DDDD," Vdc"
820   PRINT
830   PRINT "                          Positive polarity leakage "
840   PRINT "                             Direct       Channels       Tree A
Tree B"
850   PRINT USING Format;"HI to LO
",Result(0,0),Result(0,1),Result(0,2),Result(0,3)
860   PRINT USING Format;"HI to Chassis
",Result(1,0),Result(1,1),Result(1,2),Result(1,3)
870   PRINT USING Format;"LO to Chasis
",Result(2,0),Result(2,1),Result(2,2),Result(2,3)
880   PRINT
890   PRINT "                             Negative polarity leakage "
900   PRINT "                                Direct       Channels       Tree A
Tree B"
910   PRINT USING Format;"HI to LO
",Result(3,0),Result(3,1),Result(3,2),Result(3,3)
920   PRINT USING Format;"HI to Chassis
",Result(4,0),Result(4,1),Result(4,2),Result(4,3)
930   PRINT USING Format;"LO to Chasis
",Result(5,0),Result(5,1),Result(5,2),Result(5,3)
940   END
```

Typical Result

	Positive polarity leakage			
	Direct	Channels	Tree A	Tree B
DIRECT HI to DIRECT LO	0.0021 Vdc	0.0015 Vdc	0.0020 Vdc	0.0018 Vdc
HI to CHASSIS	0.0019 Vdc	0.0020 Vdc	0.0022 Vdc	0.0022 Vdc
LO to CHASSIS	0.0015 Vdc	0.0022 Vdc	0.0019 Vdc	0.0023 Vdc
	Negative polarity leakage			
	Direct	Channels	Tree A	Tree B
DIRECT HI to DIRECT LO	0.0022 Vdc	0.0026 Vdc	0.0025 Vdc	0.0028 Vdc
HI to CHASSIS	0.0028 Vdc	0.0030 Vdc	0.0026 Vdc	0.0026 Vdc
LO to CHASSIS	0.0038 Vdc	0.0033 Vdc	0.0028 Vdc	0.0032 Vdc

Performance Test Record

Table 2-1, *Performance Test Record*, is a form you can copy and use to record performance verification test results for the FET Multiplexer. Table 2-1 shows multiplexer test limits, DMM measurement uncertainty, and test accuracy ratio values (TAR).

Test Limits

Test limits are defined for Closed Channel Resistance and Leakage (input isolation) using the specifications in *Appendix A* of the appropriate *User's Manual*. The closed channel resistance and leakage tests are single-ended, meaning that there is an upper limit OR a lower limit but not both. In Table 2-1, the minimum or maximum column is blank for a single ended test.

Measurement Uncertainty

For the performance verification tests in this manual, measurement uncertainties are calculated based on the Agilent 3458A Digital Multimeter. The measurement uncertainty shown in Table 2-1 is the accuracy of the Agilent 3458A using 90-day specifications. The calculations follow.

Closed Channel Resistance Test

Conditions:

- 2-wire Ohms function, 10 kΩ range
- 90 day specifications
- Worst case reading = 3.1 kΩ

MU = (8 *ppm of Reading* + 0.5 *ppm of Range*)

$$= ((8 \times 10^{-6} * 3100) + (0.5 \times 10^{-6} * 10^{4}))$$

$$= 0.03\ \Omega$$

Leakage Test

Conditions:

- DC Volts function, 100 *m*V range
- 90 day specifications
- Worst case reading = 0.01 V
- Resistor value: 99 kΩ < R < 101 kΩ
- Power supply value: 9.9 Vdc < PS < 10.1 Vdc

3458 Uncert = (5 *ppm of Reading* + 10 *ppm of Range*)

$=((5 \text{ X } 10^{-6} * 0.01) + (10 \text{ X } 10^{-6} * 0.1))$

$= 1.05 \text{ X } 10^{-6}$ Volts

$$\text{Resistor Uncert} = \left(\frac{10}{10^8 + R_{MAX}} * R_{MAX} \right) - \left(\frac{10}{10^8 + R_{MIN}} * R_{MIN} \right)$$

$= (1.008 \, X \, 10^{-2}) - (9.89 \, X \, 10^{-3})$

$=1.99 \, X \, 10^{-4}$ Volts

$$\text{Power Supply Uncert} = \left(\frac{PS_{MAX}}{1.001 \, X \, 10^8} * 10^5 \right) - \left(\frac{PS_{MIN}}{1.001 \, X \, 10^8} * 10^5 \right)$$

$= (1.008 \, X \, 10^{-2}) - (9.89 \, X \, 10^{-3})$

$= 1.99 \, X \, 10^{-4}$ Volts

MU = *3458A Uncert* + *Resistor Uncert* + *Power Supply Uncert*

$= (1.05 \text{ X } 10^{-6}) + (1.99 \text{ X } 10^{-4}) + (1.99 \text{ X } 10^{-4})$

$= 3.99 \text{ X } 10^{-4}$ Volts

Test Accuracy Ratio (TAR)

Test Accuracy Ratios (TAR) are not defined for single-ended measurements, so all closed channel resistance and leakage current tests show NA (Not Applicable) in the TAR column.

Table 2-1. Performance Test Record (Page 1 of 2)

Model ______________________________	**Report No.** _____________________	**Date** ___________

General Information

Test Facility:

Name __________________________________	Report No. _______________________________
Address __________________________________	Date __________________________________
City/State ________________________________	Customer _________________________________
Phone __________________________________	Tested by _______________________________

Special Notes:

____

____

____

____

Test Equipment Record

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1. ______________________________	______________	______________	______________
2. ______________________________	______________	______________	______________
3. ______________________________	______________	______________	______________

Table 2-1. Performance Test Record (Page 2 of 3)

Model ______________________________	**Report No.** ____________________	**Date** ___________

Test No/Description	Minimum* Value	Measured Value (V)		Maximum Value	Meas Uncert	Test Acc Ratio (TAR)
2-1. Closed Channel Resistance (Values in Ohms)						
Channels		HI	LO			
0		________	________	3100	3E-2	NA
1		________	________	3100	3E-2	NA
2		________	________	3100	3E-2	NA
3		________	________	3100	3E-2	NA
4		________	________	3100	3E-2	NA
5		________	________	3100	3E-2	NA
6		________	________	3100	3E-2	NA
7		________	________	3100	3E-2	NA
8		________	________	3100	3E-2	NA
9		________	________	3100	3E-2	NA
10		________	________	3100	3E-2	NA
11		________	________	3100	3E-2	NA
12		________	________	3100	3E-2	NA
13		________	________	3100	3E-2	NA
14		________	________	3100	3E-2	NA
15		________	________	3100	3E-2	NA
Tree A		________	________	3100	3E-2	NA
Tree B		________	________	3100	3E-2	NA

*Single-sided specification - Minimum value does not apply

Table 2-1. Performance Test Record (Page 3 of 3)

Model ______________________________	**Report No.** _____________________	**Date** ___________

Test No/Description	Minimum Value *	Measured Value (V)	Maximum Value	Meas Uncert	Test Acc Ratio (TAR)
2-2: Leakage (Values in Volts)					
Positive polarity					
HI to LO					
Direct		___________________	0.01	3.99E-4	NA
Channels		___________________	0.01	3.99E-4	NA
Tree A		___________________	0.01	3.99E-4	NA
Tree B		___________________	0.01	3.99E-4	NA
HI to Chassis					
Direct		___________________	0.01	3.99E-4	NA
Channels		___________________	0.01	3.99E-4	NA
Tree A		___________________	0.01	3.99E-4	NA
Tree B		___________________	0.01	3.99E-4	NA
LO to Chassis					
Direct		___________________	0.01	3.99E-4	NA
Channels		___________________	0.01	3.99E-4	NA
Tree A		___________________	0.01	3.99E-4	NA
Tree B		___________________	0.01	3.99E-4	NA
Negative polarity					
HI to LO					
Direct		___________________	0.01	3.99E-4	NA
Channels		___________________	0.01	3.99E-4	NA
Tree A		___________________	0.01	3.99E-4	NA
Tree B		___________________	0.01	3.99E-4	NA
HI to Chassis					
Direct		___________________	0.01	3.99E-4	NA
Channels		___________________	0.01	3.99E-4	NA
Tree A		___________________	0.01	3.99E-4	NA
Tree B		___________________	0.01	3.99E-4	NA
LO to Chassis					
Direct		___________________	0.01	3.99E-4	NA
Channels		___________________	0.01	3.99E-4	NA
Tree A		___________________	0.01	3.99E-4	NA
Tree B		___________________	0.01	3.99E-4	NA

*Single-sided specification - Minimum value does not apply

Chapter 3
Replaceable Parts

Introduction

This chapter contains information to order replaceable parts for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers. Table 3-1 lists replaceable parts for major assemblies of the FET Multiplexers. Table 3-2 lists selected mechanical parts for the Component assembly. Table 3-3 lists parts for the terminal case. Table 3-4 shows reference designators for the parts listed in Tables 3-1 through 3-3. Table 3-5 shows the manufacturer code list for these parts.

To order a part listed in Table 3-1 through through 3-3, specify the Agilent Technologies part number and the quantity required. Send the order to your nearest Agilent Technologies Sales and Support Office.

Replaceable Parts Lists

Table 3-1 lists the part numbers of the major assemblies of the FET Multiplexers. Table 3-2 lists mechanical replaceable parts for the Component Assembly (common to all FET Multiplexers). Table 3-3 lists replaceable parts for the Terminal Case Assembly (Common to all FET Multiplexers)

Figure 3-1 shows the Component Assembly and Figure 3-2 shows the Terminal Case Assembly.

A CLIP package, including component level replaceable parts lists, is available for the FET Multiplexers (order Agilent part number E1351-90033).

Exchange Assembly

The component assembly may be replaced on an exchange basis. Exchange assemblies are available only on a trade-in basis. Defective assemblies must be returned for credit. Order assemblies for spare parts stock by the new assembly part number given in Table 3-1. Terminal blocks and case assemblies are not available for exchange. The component assembly exchange part number is: **E1351-69201**

Table 3-1. FET Multiplexer Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
			Agilent E1351A		
A1	E1351-66510	1	**TERMINAL BLOCK FOR MULTIPLEXER**	28480	E1351-66510
A2	E1351-66201	1	**16-CHANNEL FET MULTIPLEXER** (See Figure 3-1 and Table 3-2)	28480	E1351-66201
A3	E1300-84401	1	**CASE ASSEMBLY FOR MULTIPLEXER** (See Figure 3-2 and Table 3-3)	28480	E1300-84401
			Agilent E1352A		
A1	E1351-66201	1	**16-CHANNEL FET MULTIPLEXER** (See Figure 3-1 and Table 3-2)	28480	E1351-66201
A2	E1352-66510	1	TERMINAL CARD 48 C FET MUX	28480	E1352-66510
A4	E1300-84401	1	CASE ASSEMBLY FOR MULTIPLEXER (See Figure 3-2 and Table 3-3)	28480	E1300-84401
			Agilent E1353A		
A1	E1351-66201	1	**16-CHANNEL FET MULTIPLEXER** (See Figure 3-1 and Table 3-2)	28480	E1351-66201
A2	E1353-66510	1	PC BOARD ASSY; TERMINAL MODULE	28480	E1353-66510
A4	E1300-84401	1	**CASE ASSEMBLY FOR MULTIPLEXER** (See Figure 3-2 and Table 3-3)	28480	E1300-84401
			Agilent E1357A		
A1	E1355-66510	1	**TERMINAL RELAY - 120 OHM FOR MUX**	28480	E1355-66510
A2	E1351-66201	1	**16-CHANNEL FET MULTIPLEXER** (See Figure 3-1 and Table 3-2)	28480	E1351-66201
A4	E1300-84401	1	**CASE ASSEMBLY FOR MULTIPLEXER** (See Figure 3-2 and Table 3-3)	28480	E1300-84401
			Agilent E1358A		
A1	E1356-66510	1	**TERMINAL RELAY - 350 OHM FOR MUX**	28480	E1356-66510
A2	E1351-66201	1	**16-CHANNEL FET MULTIPLEXER** (See Figure 3-1 and Table 3-2)	28480	E1351-66201
A4	E1300-84401	1	**CASE ASSEMBLY FOR MULTIPLEXER** (See Figure 3-2 and Table 3-3)	28480	E1300-84401

Table 3-2. FET Multiplexer Component Assembly Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
	E1351-66201	1	**16-CHANNEL FET MULTIPLEXER** (See figure 3-1)	28480	E1351-66201
LBL1	E1300-84308	1	LBL LOGO Agilent B SIZE	28480	E1300-84308
LBL2	E1300-84309	1	LBL LOGO VXI B SIZE	28480	E1300-84309
F1	2110-0712	1	FUSE-SUBMINIATURE 4A 125V NTD AX	75915	R251004T1
F2	2110-0665	1	FUSE-SUBMINIATURE 1A 125V NTD AX UL CSA	75915	R251001T1
J1	1252-1596	2	CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96CPC-SRI-TR
J2	1252-3712	1	CONNECTOR-POST TYPE .100-PIN-SPCG 12-CONTACT	18873	68668-004
J3	1252-3868	1	CONNECTOR-POST TYPE .100-PIN-SPCG 6-CONTACT	18873	68668-071
J4	1251-8735	1	CONNECTOR-POST TYPE .100-PIN-SPCG 8-CONTACT	18873	67997-608
MP1-MP2	1400-1546	2	BRACKET PC BOARD HOLDER; BLACK; EXTRUDED	28480	1400-1546
P1	1252-1596		CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96CPC- SRI-TR
P4	1258-0247	1	JUMPER-4 POSITIONS HOUSING MATERIAL	18873	69146-204
PNL1	E1351-00202	1	PNL-RR MATRIX SW	28480	E1351-00202
SCR1-SCR2	0515-0444	2	SCREW-MACHINE M2.5 X 0.45 8MM-LG PAN-HD	28480	0515-0444
SCR3-SCR4	0515-1968	2	SCREW PHM 2.5 X 11	28480	0515-1968

Table 3-3. Terminal Case Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
	E1300-84401	1	**CASE ASSEMBLY FOR MULTIPLEXER** (See Figure 3-2)	28480	E1300-84401
CS1	03852-01201	1	CLAMP	28480	03852-01201
CS2	03852-86701	1	PAD - CLAMP	28480	03852-86701
CS3	0515-2109	1	SCREW - MACHINE 10-24 .625-IN-LG PAN-HD-SLT	28480	0515-2109
CS4	1390-0846	2	FASTENER-CAPTIVE SCREW M2.5 X 1.45 THREAD	28480	1390-0846
CS5	E1300-01202	1	CLAMP-STRAIN RELEIF	28480	E1300-01202
CS6	E1300-44101	1	COVER-TOP, TERMINAL HOUSING, MOLDED	28480	E1300-44101
CS7	E1300-44102	1	COVER-BOTTOM, TERMINAL HOUSING	28480	E1300-44102

Table 3-4. FET Multiplexers Reference Designators

FET Multiplexers Reference Designators	
A .... assembly	MP..................................... mechanical part
LBL .... label	P......................... electrical connector (plug)
F .... fuse	PNL .... panel
J.......................... electrical connector (jack)	SCR.. screw
JM.. jumper	SW .... switch

Table 3-5. FET Multiplexer Code List of Manufacturers

Mfr. Code	Manufacturer's Name	Manufacturer's Address	Zip Code
06776	ROBINSON NUGENT INC	NEW ALBANY NY US	47150
18873	DUPONT E I DE NEMOURS & CO	WILMINGTON DE US	19801
26742	METHODE ELECTRONICS INC	CHICAGO IL US	60656
28480	AGILENT TECHNOLOGIES - CORPORATE	PALO ALTO CA US	94304
75915	LITTELFUSE INC	DES PLAINES IL US	60016
76381	3M CO	ST PAUL MN US	55144
81073	GRAYHILL INC	LA GRANGE IL US	60525

Mechanical Parts Locators

Figure 3-1 shows the mechanical replaceable parts on the component assembly (Agilent PN E1351-66201). Figure 3-2 shows the mechanical replaceable parts for the terminal case assembly (Agilent PN E1300-84401).

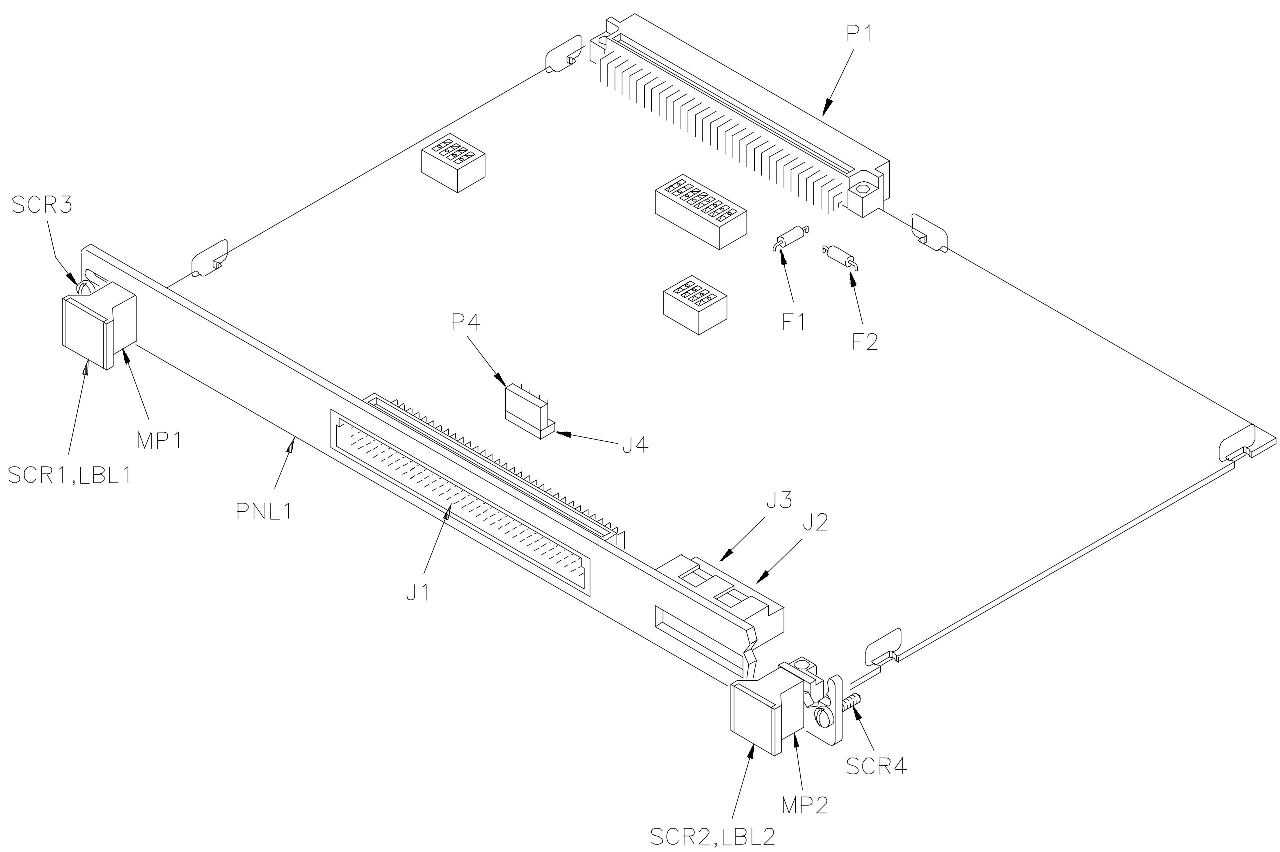


Figure 3-1. Component Assembly Replaceable Parts

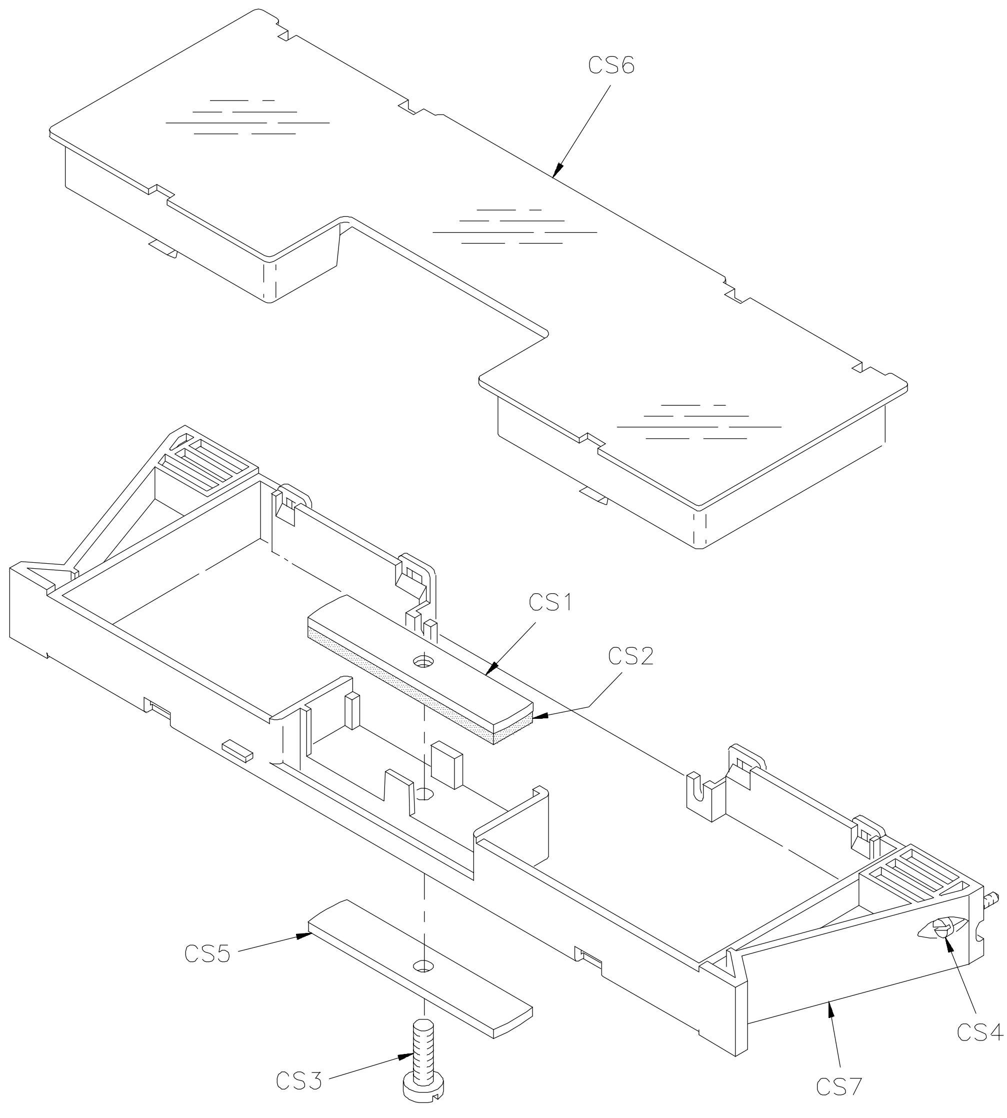


Figure 3-2. Terminal Case Assembly Replaceable Parts

Chapter 4
Service

Introduction

This chapter contains service information for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers. Also included are trouble shooting, repair, and maintenance guidelines.

WARNING

Do not perform any of the service procedures shown unless you are a qualified, service-trained technician and have read the WARNINGS and CAUTIONS in Chapter 1.

Equipment Required

Equipment required for module troubleshooting and repair is listed in *Table 1-1, Recommended Test Equipment*. Any equipment that satisfies the requirements given in the table may be substituted. To avoid damage to the screw head slots, use a T8 Torx driver to remove the front panel handles.

Service Aids

See *Chapter 3 — Replaceable Parts* for descriptions and locations of Agilent E1351A, E1352A, E1353A, E1357A, and E1358A replaceable parts. Service notes, manual updates, and service literature for the FET Multiplexers may be available through Agilent Technologies. For information, contact your nearest Agilent Technologies Sales and Service Office.

FET Multiplexer Description

The Agilent E1351A, E1352A, E1353A, E1357A, and E1358A all use a common component assembly. The component assembly contains all the FET switches and their associated protection circuitry. Each terminal block configures the component assembly to the appropriate type of switch. Figures 4-1 through 4-4 show a simplified switching diagram for each FET Multiplexer.

The terminal card contains the model identification code and the installation of the terminal card before applying mainframe power ensures that the type of switch is correctly identified. Optionally, the model identification can be set on the component assembly to allow it to be correctly identified without a terminal card installed. The component module also contains jumpers that place the internal +4.6 V strain gage excitation voltage on the terminal block

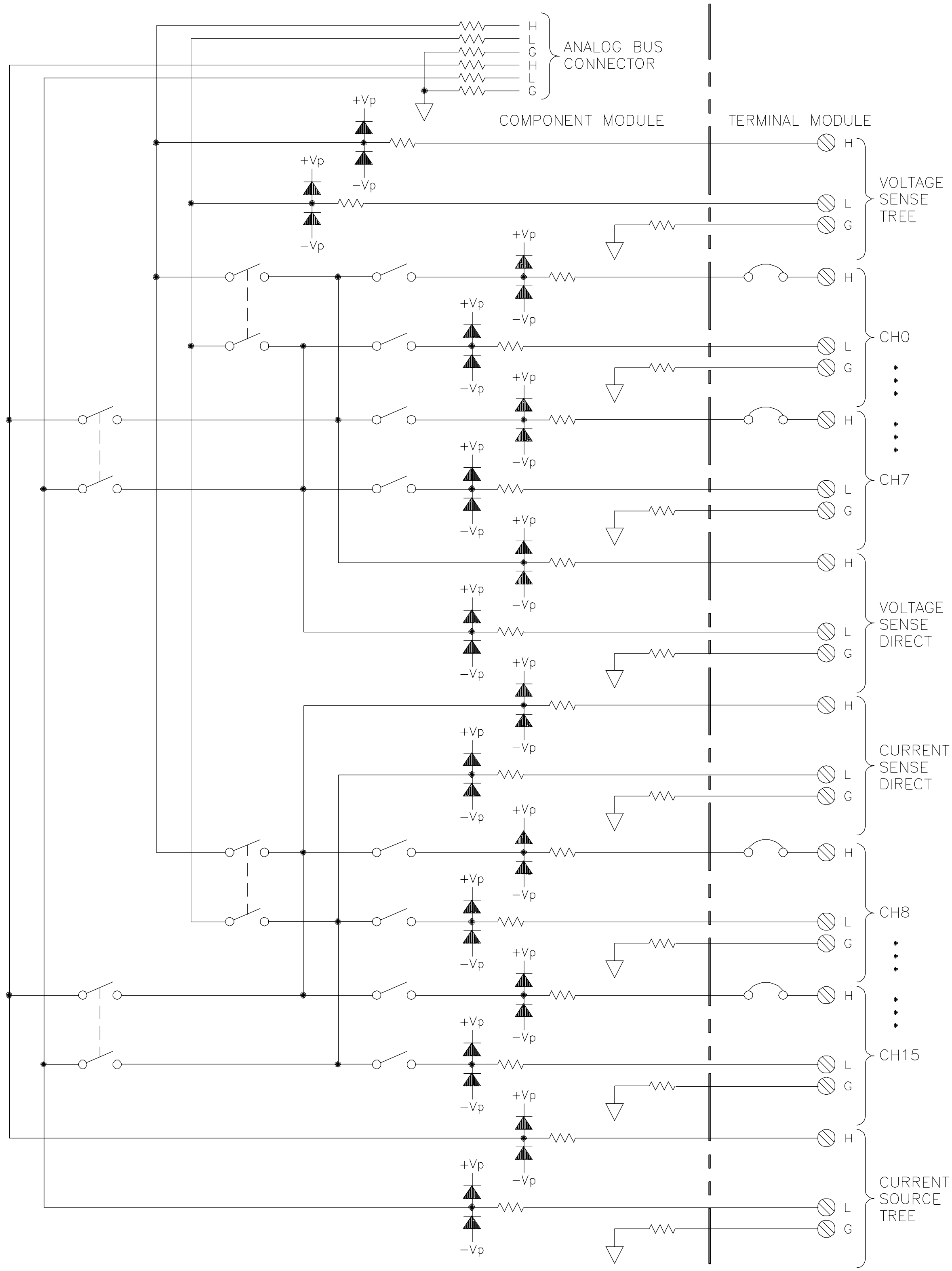


Figure 4-1. Agilent E1351A Simplified Switch Diagram

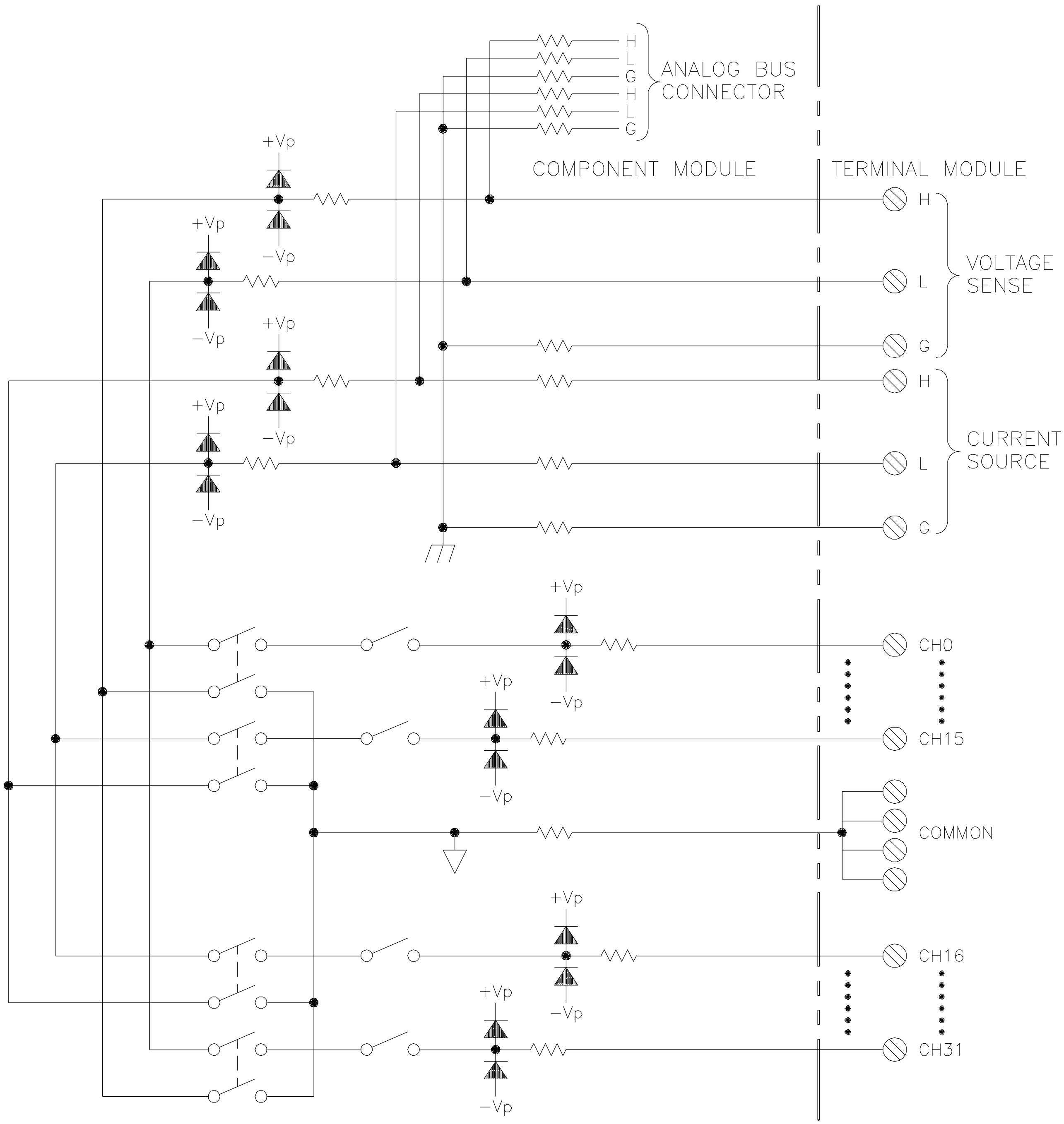


Figure 4-2. Agilent E1352A Simplified Switch Diagram

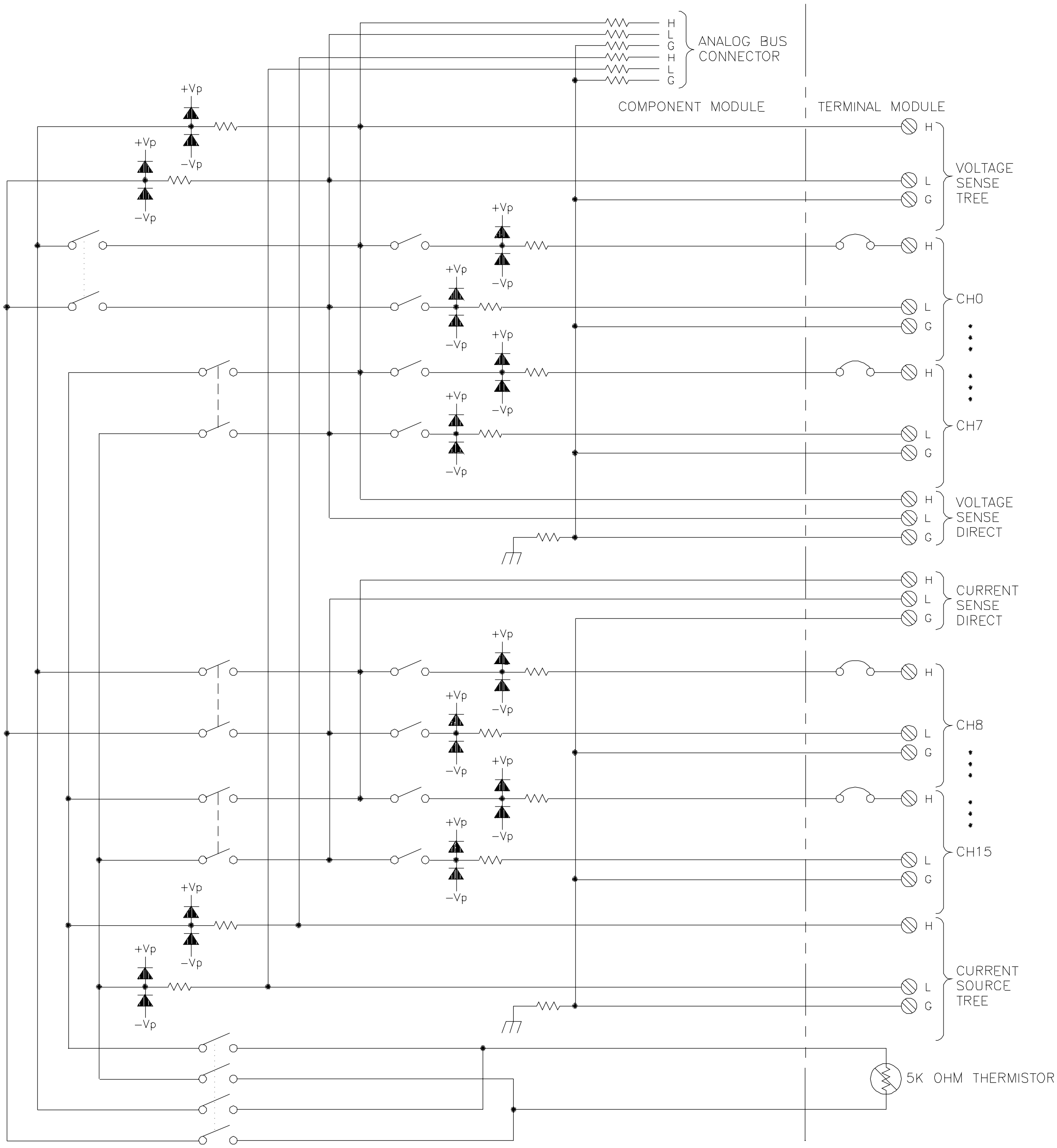


Figure 4-3. Agilent E1353A Simplified Switch Diagram

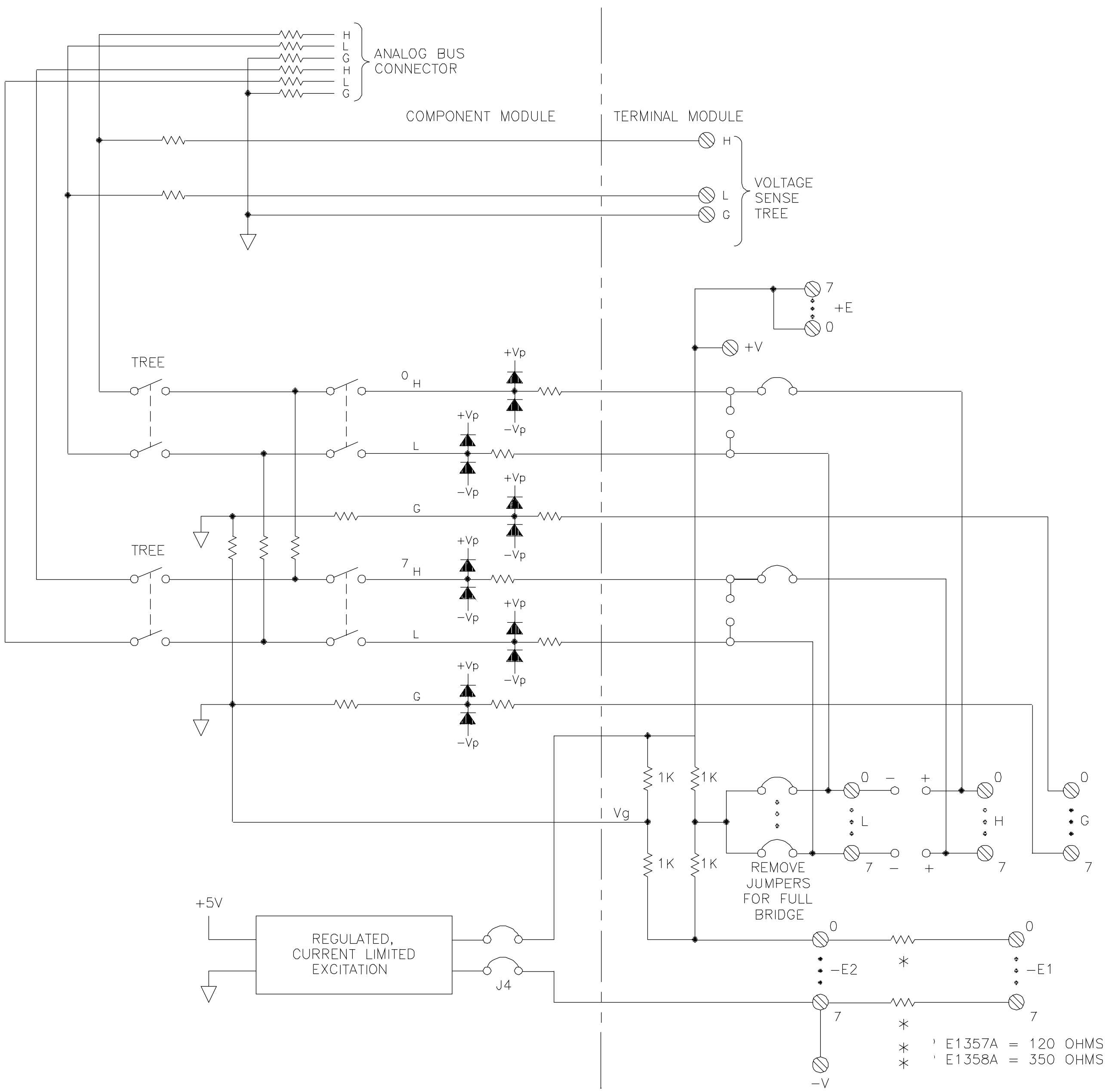


Figure 4-4. Agilent E1357A/58A Simplified Switch Diagram

for use with the Agilent E1357A and Agilent E1358A Strain Gage FET Multiplexers.

Repair Strategy

Agilent Technologies recommends replacement of the entire assembly in the event of a failure. Procedures in this chapter describe troubleshooting techniques. A CLIP package, including component level replaceable parts lists, is available for the FET Multiplexers (order Agilent part number E1351-90033). The component assembly is available as an exchange asembly as described in *Chapter 3 — Replaceable Parts*. Be sure to perform the tests and checks in Table 4-2 before exchanging an assembly.

Troubleshooting Techniques

To troubleshoot a FET Multiplexer problem you must first identify the problem and then isolate the cause of the problem to a replaceable assembly. See *Chapter 3 — Replaceable Parts* for descriptions and locations of Agilent E1351A, E1352A, E1353A, E1357A, and E1358A replaceable parts.

Identifying the Problem

Table 4-1 lists some common problems for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers, along with symptoms and possible solutions. If the problem cannot be identified using these steps, replace the assembly.

Table 4-1. FET Multiplexer Typical Problems

Symptom	Recommended Action
Non-zero error code in response to SYST:ERR?	See *Appendix A* of the appropriate *FET Multiplexer User's Manual*.
Module not responding to commands.	See "Making Visual Checks" in this chapter
Module fails Closed Channel Resistance Test (Test 2-1) or Leakage Test (Test 2-2)	See "Testing the Module" in this chapter

Making Visual Checks

Visual checks for the FET Multiplexers include the following. See Table 4-2 for typical checks.

- Check switches/jumpers
- Check for heat damage
- Checking connector contacts

NOTE

See the appropriate FET Multiplexer User's Manual for information on logical address and IRQ settings. If there are no apparent problems following the visual checks, run the Performance Verification Tests in Chapter 2 to see if the module is defective.

Table 4-2. FET Multiplexer Visual Tests/Checks

Test/Check	Reference Designator	Check	Action/Notes
Heat Damage	- - - - - - - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing	If there is damage, do not operate the module until you have corrected the problem.
Switch/Jumper Settings	SP2 SP1 SP3 J4 JM1	IRQ Level setting Logical address setting Card ID Strain Excitation Remote Ground Sense	Factory set at 1 Factory set at 112 Factory set 00 Factory set to OFF Factory Installed
Component Assembly	F1, F2 J1, J2, J3 P1	Fuse continuity Dirty or bent connector pins Dirty or bent connector pins	Check fuses with ohmmeter Straighten/clean pins Straighten/clean pins

Testing the Module

You can use the tests and checks in *Chapter 2 — Verification Tests* to identify a problem with the assembly. See *Chapter 3 — Replaceable Parts* for locations of mechanical parts.

Repair and Maintenance Guidelines

This section provides guidelines for repairing and maintaining the FET Multiplexer including:

- ESD precautions
- Soldering printed circuit boards
- Post-repair safety checks

ESD Precautions

Electrostatic discharge (ESD) may damage static sensitive devices in the module. This damage can range from slight parameter degradation to catastrophic failure. When handling the module observe the following guidelines:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling module components.

- If a device requires soldering, be sure the assembly is placed on a pad of conductive material. Also, be sure that you, the pad, and the soldering iron tip are grounded to the assembly.

Soldering Printed Circuit Boards

The etched circuit board of this module has plated-through holes that provide a solder path to both sides of the insulating material. Soldering can be done from either side of the board with equally good results. When soldering to any circuit board, keep in mind the following guidelines:

- Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board, adjacent components, or both.

- Do not use a high power soldering iron on etched circuit boards, as excessive heat may lift a conductor or damage the board.

- Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, be sure that the equipment is properly grounded.

Post-Repair Safety Checks

After making repairs to the module, inspect the module for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and correct the cause of the condition. Then perform Test 2-1 as described in *Chapter 2 — Verification Tests* to verify that the module is functional.

Chapter A
Verification Tests - C Programs

Functional Verification Test

This program is designed to do the Functional Verification Test found in *Chapter 2 - Verification Tests*.

Example: Self Test

The Functional Verification Test for the Agilent E1351A, E1352A, E1353A, E1357A, and E1358A FET Multiplexers consists of sending the *IDN? command and checking the response. This test can be used to verify that the FET Multiplexer is connected properly and is responding to a basic command.

NOTE

This program assumes a primary address of 09 and a secondary address of 14. If your FET Multiplexer address does not match this, you must either change the FET Multiplexer address setting or change the program line #define ADDR "hpib7,9,14" *to match your FET Multiplexers address setting.*

```
#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,14"                 /* Address of device */

void main (void)
{
  INST id;                                /* Define id as an instrument */
  char a[256] = {0};                      /* Result variable */

  ionerror (I_ERROR_EXIT);
  id = iopen (ADDR);                      /* Open instrument session */

  iprintf(id, "*IDN?\n");                 /* Send *IDN? command */
  iscanf (id, "%t", a);                   /* Get response */
  printf("\n %s", a);                     /* Print result */
  getchar();                              /* Pause */
  iclose (id);                            /* Close instrument session */
 }
```

Performance Verification Tests

These programs are designed to do the Performance Verification Tests found in *Chapter 2 - Verification Tests*.

NOTE

These programs assume a primary address of 09 and a secondary address of 14. If your FET Multiplexer address does not match this, you must either change the FET Multiplexer address setting or change the program lines #define ADDR "hpib7,9,14" *to match your FET Multiplexers address setting.*

Example: Closed Channel Resistance Test

This example performs a closed channel resistance test of all measurement paths. If a FET on resistance is >3.1 kΩ , the program prints a message indicating which channel has failed. Before the closed channel measurement, the program checks for stuck channels. If a stuck channel is found, the program prints a message and halts.

```
/*  Closed-channel Resistance Test            E1351A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,14"                    /* Address of device */
#define DMM "hpib7,22"

void main (void)
{
 INST id, dm;                                /* Define id and dm as an instrument */
 int i, j;
 double result[2][15], tree[2][2], value;
 char cr[256];
 char *path;

 #if defined(__BORLANDC__) && !defined(__WIN32__)
   _InitEasyWin();
 #endif

 ionerror(I_ERROR_EXIT);
 dm = iopen (DMM);                   /* Open instrument session */
 id = iopen(ADDR);

 printf ("\n\n\n\nInstall Component Assembly and Test Fixture");
 printf ("\n\n 1. Turn Mainframe AND 3458a DMM power OFF.");
 printf ("\n 2. Connect GPIB Cable between mainframe and DMM.");
 printf ("\n 3. Install Agilent E1351A Component Assembly into Mainframe.");
 printf ("\n 4. Attach Test Fixture to Component Assembly.");
 printf ("\n 5. Turn Mainframe and DMM power ON");
 printf ("\n 6. Press ENTER when ready to begin testing.");
 getchar ();
```

```
/*..........................Measure Closed Channel Resistance...........*/

iprintf (id, "*RST\n");
iprintf (dm, "PRESET NORM;TRIG HOLD\n");
iprintf (dm, "END ALWAYS\n");
iprintf (dm, "FUNC OHM\n");

for (i = 0;i <= 1; i++)
{
  if (i == 0)  path = "HI";
  else         path = "LO";

  printf ("\n\nChannel %s to Direct %s Measurements", path, path);
  printf ("\n\n 1. Connect DMM Input HI lead to Channel %s", path);
  printf ("\n 2. Connect DMM Input LO lead to Direct %s", path);
  printf ("\n 3. Press ENTER when connections are complete");
  getchar ();

  /*-------Check for stuck channels------*/

  iprintf (id, "*RST\n");
  iprintf (dm, "TRIG SGL\n");
  iscanf (dm, "%lf", &value);
  iscanf  (dm, "%t", cr);

  if (value < 10000)
  {
    printf ("\n\n***** Measurement indicates a stuck channel *****");
    printf ("\n***** Correct the problem before proceeding *****");
    goto EXIT;
  }

  for (j = 0;j <= 15; j++)
  {
    if (j < 10)   iprintf (id, "CLOS (@10%u)\n", j);
    else          iprintf (id, "CLOS (@1%u)\n", j);
    iprintf (dm, "TRIG SGL\n");
    iscanf  (dm, "%lf", &result[i][j]);
    iscanf  (dm, "%t", cr);
    printf ("\nchannel %u resistace = %6.4lf", j, result[i][j]);

    if (j < 10)  iprintf (id, "OPEN (@10%u)\n", j);
    else         iprintf (id, "OPEN (@1%u)\n", j);

    if (result[i][j] > 3100) printf ("\n*** Resistance for Channel %u is  3.1 kOhms ***
%6.4lf Ohms", j, result[i][j]);

  }
  if (i == 0)
  {
    printf ("\n\nMeasurements complete for channel HI.");
    printf ("\nPress ENTER for channel LO measurements");
    getchar ();
  }
  else
  {
    printf ("\n\nMeasurements complete for channel LO.");
  }

}
```

```
printf ("\n\nMeasurements complete for Channel HI and LO");
printf ("\nPress ENTER for Tree Switch measurements");
getchar ();

/*..........................Tree Switch Measurements.................................*/

iprintf (dm, "PRESET NORM;TRIG HOLD\n");
iprintf (dm, "END ALWAYS\n");
iprintf (dm, "FUNC OHM\n");

for (i = 0;i <= 1; i++)
{
 if (i == 0)
 {
  path = "HI";
  printf ("\n\nTree HI to Direct HI Measurements");
  printf ("\n\n 1. Connect DMM Input HI leads to Tree HI");
  printf ("\n 2. Connect DMM Input LO leads to Direct HI");
 }
 else
 {
  path = "LO";
  printf ("\n\nTree LO to Direct LO Measurements");
  printf ("\n\n 1. Connect DMM Input HI leads to Tree LO");
  printf ("\n 2. Connect DMM Input LO leads to Direct LO");
 }

 printf ("\n 3. Press ENTER when connections are complete.");
 getchar ();

 iprintf (id, "*RST\n");

 /*-------Check for stuck channels------*/

 iprintf (dm, "TRIG SGL\n");
 iscanf (dm, "%lf", &value);
 iscanf  (dm, "%t", cr);

 if (value < 10000)
 {
  printf ("\n\n***** Measurement indicates a stuck channel *****");
  printf ("\n***** Correct the problem before proceeding *****");
  goto EXIT;
 }

 for (j = 0; j <= 1; j++)
 {
  iprintf (id, "SCAN:PORT ABUS\n");
  if (j == 0)  iprintf (id, "CLOS (@100)\n");
  else         iprintf (id, "CLOS (@115)\n");
  iprintf (dm, "TRIG SGL\n");
  iscanf  (dm, "%lf", &tree[i][j]);
  iscanf  (dm, "%t", cr);
  if (j == 0)  iprintf (id, "OPEN (@100)\n");
  else         iprintf (id, "OPEN (@115)\n");
```

```
         if (tree[i][j] > 3100)
         {
           if (j == 0)  printf ("\n*** Resistance for A Tree Switch is  3.1 kOhms");
           else         printf ("\n*** Resistance for B Tree Switch is  3.1 kOhms");
         }
       }

       if (i == 0)
       {
         printf ("\n\nMeasurements complete for Tree Switch HI");
         printf ("\nPress ENTER forTree Switch LO measurements");
         getchar();
       }
       else
       {
         printf ("\n\nMeasurements complete for Tree Switch LO");
       }

     }

     printf ("\n\nClosed channel resistance measurements complete.");
     printf ("\nPress ENTER to display measurement results.");
     getchar ();

     /*..........................Display Measurement Results...............................*/

     printf ("\n\n-------------------------------------------");
     printf ("\n\nClosed Channel Resistance measurement Results\n");
     for (j = 0;j <= 15; j++)
     {
       printf ("\n Channel %u   HI = %6.4lf Ohms   LO = %6.4lf Ohms", j+100,
   result[0][j], result[1][j]);
     }

     printf ("\n\n Tree A       HI = %6.4lf Ohms   LO = %6.4lf Ohms", tree[0][0],
   tree[1][0]);
     printf ("\n Tree B       HI = %6.4lf Ohms   LO = %6.4lf Ohms", tree[0][1], tree[1][1]);

   EXIT:
     iclose (id);iclose (dm);                              /* Close instrument session */
   }
```

Example: Leakage Current Test

This example performs a leakage test from HI to LO, HI to Chassis, and LO to Chassis. If the leakage is too high (caused by a failure of the input impedance), the test prints a message indicating which leakage path has failed and halts.

```
/*  Leakage Current Test           E1351A  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,14"                    /* Address of device */
#define DMM "hpib7,22"

void main (void)
{
 INST id, dm;                                /* Define id and dm as an instrument */
 int i;
 double result[6][4], value;
 char cr[256];
 char *path;

 #if defined(__BORLANDC__) && !defined(__WIN32__)
   _InitEasyWin();
 #endif

 ionerror(I_ERROR_EXIT);

 dm = iopen (DMM);
 id = iopen(ADDR);

 itimeout (dm, 10000);
 itimeout (id, 10000);

 printf ("\n\n\nInstall Component Assembly and Test Fixture");
 printf ("\n\n 1. Turn Mainframe AND 3458a DMM power OFF.");
 printf ("\n 2. Connect GPIB Cable between mainframe and DMM.");
 printf ("\n 3. Install Agilent E1351A Component Assembly into Mainframe.");
 printf ("\n 4. Attach Test Fixture to Component Assembly.");
 printf ("\n 5. Turn Mainframe and DMM power ON");
 printf ("\n 6. Press ENTER when ready to begin testing.");
 getchar ();

 /*..........................Measure Leakage.......................................*/

 iprintf (dm, "PRESET NORM;TRIG HOLD\n");
 iprintf (dm, "END ALWAYS\n");
 iprintf (dm, "FUNC DCV\n");

 for (i = 0;i <= 5; i++)
 {
   iprintf (id, "*RST\n");

   printf ("\n\n1. Connect 100 kOhm resistor from DMM Input HI to DMM Input LO");
```

```
    if (i == 0)
    {
      printf ("\n2. Connect DMM input HI leads to Power Supply HI");
      printf ("\n3. Connect DMM input LO leads to Direct HI");
      printf ("\n4. Connect Power Supply LO to Direct LO");
    }
    if (i == 1)
    {
      printf ("\n2. Connect DMM input HI leads to Direct HI");
      printf ("\n3. Connect DMM input LO leads to Power Supply LO");
      printf ("\n4. Connect Power Supply HI to Direct LO");
    }
    if (i == 2)
    {
      printf ("\n2. Connect DMM input HI leads to Power Supply HI");
      printf ("\n3. Connect DMM input LO leads to Direct LO");
      printf ("\n4. Connect Power Supply LO to Chassis");
    }
    if (i == 3)
    {
      printf ("\n2. Connect DMM input HI leads to Direct HI");
      printf ("\n3. Connect DMM input LO leads to Power Supply LO");
      printf ("\n4. Connect Power Supply HI to Chassis");
    }
    if (i == 4)
    {
      printf ("\n2. Connect DMM input HI leads to Power Supply HI");
      printf ("\n3. Connect DMM input LO leads to Direct LO");
      printf ("\n4. Connect Power Supply LO to Chassis");
    }
    if (i == 5)
    {
      printf ("\n2. Connect DMM input HI leads to Direct LO");
      printf ("\n3. Connect DMM input LO leads to Power Supply LO");
      printf ("\n4. Connect Power Supply HI to Chassis");
    }

    printf ("\n5. Turn ON power supply and set output for +10 Vdc");
    printf ("\n6. Press ENTER when connections are complete");
    getchar ();

    printf (".");
    iprintf (dm, "TRIG SGL\n");
    iscanf (dm, "%lf", &result[i][0]);
    iscanf (dm, "%t", cr);

    if (result[i][0] > .01)
      printf ("\n\n***** Direct path leakage out of tolerance %6.4lf Volts *****",
result[i][0]);

    /*..........................Channel Check...............................................*/

    printf (".");
    iprintf (id, "CLOS (@100)\n");
    iprintf (dm, "TRIG SGL\n");
    iscanf  (dm, "%lf", &result[i][1]);
    iscanf  (dm, "%t", cr);
```

```
    if (result[i][1] > .01)
      printf ("\n\n***** Channel path leakage out of tolerance %6.4lf Volts *****",
result[i][1]);

    /*..........................Tree Check...................................................*/

    printf (".");
    iprintf (id, "SCAN:PORT ABUS\n");
    iprintf (id, "CLOS (@100)\n");
    iprintf (dm, "TRIG SGL\n");
    iscanf  (dm, "%lf", &result[i][2]);
    iscanf  (dm, "%t", cr);

    if (result[i][2] > .01)
      printf ("\n\n***** Tree A path leakage out of tolerance %6.4lf Volts *****",
result[i][2]);

    printf (".");
    iprintf (id, "OPEN (@100)\n");
    iprintf (id, "CLOS (@115)\n");
    iprintf (dm, "TRIG SGL\n");
    iscanf (dm, "%lf", &result[i][3]);
    iscanf (dm, "%t", cr);

    if (result[i][3] > .01)
      printf ("\n\n***** Tree B path leakage out of tolerance %6.4lf Volts *****",
result[i][3]);

    printf (".");
    if (i < 5)
    {
      printf ("\n\nTest %u complete", i+1);
      printf ("\nTurn power supply OFF");
      printf ("\nPress ENTER for test %u", i+2);
      getchar ();
    }
  }
  printf ("\n\nLeakage tests complete.");
  printf ("\nPress ENTER to display measurement results.");
  getchar ();

  /*..........................Display Measurement Results................................*/

  printf ("\n\n-----------------------------------------------------------");
  printf ("\n                  Positive Polarity Leakage       \n");
  printf ("\n-----------------------------------------------------------");
  printf ("\n             Direct      Channels    Tree A      Tree B\n");

  printf ("\nHI to LO       %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc", result[0][0],
result[0][1], result[0][2], result[0][3]);
  printf ("\nHI to Chassis  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc",
result[1][0], result[1][1], result[1][2], result[1][3]);
  printf ("\nLO to Chassis  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc",
result[2][0], result[2][1], result[2][2], result[2][3]);
```

```
  printf ("\n\n-------------------------------------------------------------");
  printf ("\n                  Negative Polarity Leakage       \n");
  printf ("\n-------------------------------------------------------------");
  printf ("\n              Direct      Channels    Tree A      Tree B\n");

  printf ("\nHI to LO       %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc", result[3][0],
result[3][1], result[3][2], result[3][3]);
  printf ("\nHI to Chassis  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc",
result[4][0], result[4][1], result[4][2], result[4][3]);
  printf ("\nLO to Chassis  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc  %6.4lf Vdc",
result[5][0], result[5][1], result[5][2], result[5][3]);

  iclose (id);iclose (dm);                              /* Close instrument session */
}
```